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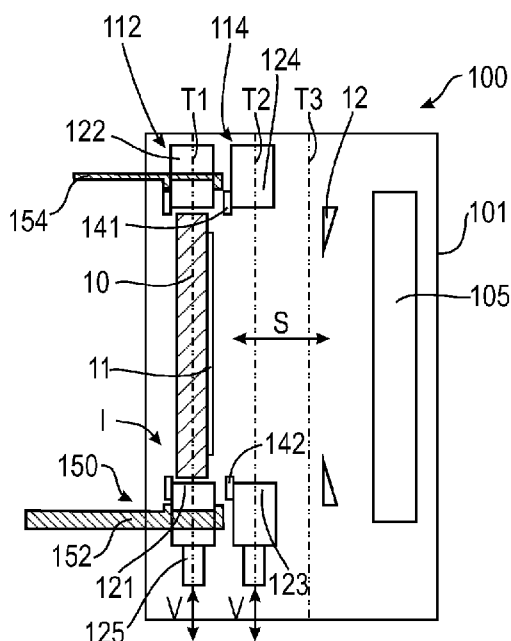


FIG. 1A

(57) Abstract: An apparatus (100) for transportation of a carrier (10) in a vacuum chamber (102) is provided. The apparatus (100) includes a first transport system (112) provided along a first transport path (T1) in a transport direction (T) and including a lower track section (121) and an upper track section (122), and a path switch assembly (150) configured to move the carrier away from the first transport path (T1) in a path switch direction (S). The apparatus further includes an actuator (125) for switching between a transport position (I) with a first distance between the lower track section (121) and the upper track section (122) and a path switch position (II) with a second distance between the lower track section (121) and the upper track section (122), the first distance being smaller than the second distance. Further, a system including a path switch assembly as well as a method of transporting a carrier in a vacuum chamber are described.

**APPARATUS FOR TRANSPORTATION OF A CARRIER, SYSTEM FOR
VACUUM PROCESSING OF A SUBSTRATE, AND METHOD FOR
TRANSPORTATION OF A CARRIER IN A VACUUM CHAMBER**

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FIELD

[0001] Embodiments of the present disclosure relate to an apparatus for transportation of
10 a carrier in a vacuum chamber, a system for the vacuum processing of a substrate, and a
method for transportation of a carrier in a vacuum chamber. Embodiments of the present
disclosure particularly relate to a vacuum system with a deposition apparatus and with a
path switch assembly configured to move a carrier between a first transport path and a
second transport path. Specifically, methods for changing a track of a carrier in a vacuum
15 chamber are described.

BACKGROUND

[0002] Techniques for layer deposition on a substrate include, for example, sputter
deposition, evaporation, and chemical vapor deposition (CVD). A sputter deposition
process can be used to deposit a material layer on the substrate, such as a layer of an
20 insulating material or a conductor material.

[0003] In order to deposit a multiple layer stack, an in-line arrangement of processing
modules can be used. An in-line processing system includes a plurality of subsequent
processing modules, such as deposition modules and optionally further processing
modules, e.g., cleaning modules and/or etching modules, wherein processing aspects are
25 subsequently conducted in the processing modules such that a plurality of substrates can
continuously or quasi-continuously be processed in the in-line processing system.

[0004] The substrate may be carried by a carrier, i.e. a carrying device for carrying the
substrate. The carrier is typically transported through a vacuum system using a transport
system. The transport system may be configured for conveying the carrier having the
30 substrate positioned thereon along one or more transport paths. At least two transport paths
can be provided next to each other in the vacuum system, e.g. a first transport path for

transporting the carrier in a forward direction and a second transport path for transporting the carrier in a return direction opposite to the forward direction.

[0005] The transportation system can have rollers or other supports configured to support and convey the carriers along the transport paths and/or from one transport path to another transport path (also referred to as a “path switch” or “track switch”). The friction between the carrier and a carrier support during the transport of the carrier can generate particles that may negatively affect the vacuum conditions inside the vacuum system. The particles can contaminate the layers deposited on the substrates, and a quality of the deposited layers can be reduced.

[0006] In view of the above, there is a need for new apparatuses for transporting a carrier in a vacuum chamber, systems for vacuum processing of a substrate, and methods for transportation of a carrier in a vacuum chamber that reduce the particle generation in a vacuum chamber. There is also a need for new apparatuses, systems and methods that provide a facilitated path switch between at least two transport paths in a vacuum chamber, while reducing the generation of particles in the vacuum chamber.

SUMMARY

[0007] In light of the above, an apparatus for transportation of a carrier in a vacuum chamber, a system for vacuum processing of a substrate, and a method for transportation of a carrier in a vacuum chamber are provided. Further aspects, benefits, and features of the present disclosure are apparent from the claims, the description, and the accompanying drawings.

[0008] According to an aspect of the present disclosure, an apparatus for transportation of a carrier in a vacuum chamber is provided. The apparatus includes a first transport system provided along a first transport path in a transport direction, wherein the first transport system includes a lower track section and an upper track section. The apparatus further includes a path switch assembly configured to move the carrier away from the first transport path in a path switch direction, and an actuator for modifying a distance between the lower track section and the upper track section of the first transport system.

[0009] The actuator may be configured for switching between a transport position with a first distance between the lower track section and the upper track section, and a path switch position with a second distance between the lower track section and the upper track section, the first distance being smaller than the second distance.

5 [0010] In some embodiments, the first transport system may be configured to contactlessly transport the carrier along the first transport path in the transport direction. The carrier may be held in a vertical orientation during the transport, particularly in a carrier transportation space between the upper track section and the lower track section. In particular, the first transport system may be a magnetic levitation system.

10 [0011] According to another aspect of the present disclosure, a system for vacuum processing of a substrate is provided. The system includes a vacuum chamber and one or more processing tools arranged in the vacuum chamber selected from the group consisting of deposition sources, sputter sources, evaporation sources, surface treatment tools, heating devices, cleaning devices, etching tools, and combinations thereof. The system further
15 includes an apparatus according to any of the embodiments described herein.

[0012] According to yet another aspect of the present disclosure, a method for transporting a carrier in a vacuum chamber is provided. The method includes transporting a carrier along a first transport path in a transport direction between a lower track section and an upper track section of a first transport system, increasing a distance between the lower
20 track section and the upper track section, and moving the carrier away from the first transport path in a path switch direction transverse to the transport direction.

[0013] According to yet another aspect of the present disclosure, a method for transportation of a carrier in a vacuum chamber is provided. The method includes transporting a carrier along a first transport path in a transport direction, and moving the
25 carrier to a second transport path horizontally offset from the first transport path, comprising lowering the carrier, moving the carrier in a path switch direction, and lifting the carrier.

[0014] Embodiments are also directed at apparatuses for carrying out the disclosed methods and include apparatus parts for performing each described method aspect. 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 apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] 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:

FIG. 1A shows a schematic view of an apparatus for transportation of a carrier according to embodiments described herein;

FIG. 1B shows a schematic view of the apparatus of FIG. 1 in a path switch position;

FIG. 2 shows a schematic top view of a system including an apparatus for transportation of a carrier according to embodiments described herein;

FIGS. 3A-H show various stages of a method for transportation of a carrier with an apparatus according to embodiments described herein;

FIGS. 4A-B show subsequent stages of a method for transportation of a carrier with an apparatus according to embodiments described herein;

FIGS. 5A-D show various stages of a method for transportation of a carrier with an apparatus according to embodiments described herein;

FIG. 6 is a flow diagram for illustrating a method for transportation of a carrier according to embodiments described herein; and

FIG. 7 is a flow diagram for illustrating a method for transportation of a carrier according to embodiments described herein.

DETAILED DESCRIPTION OF EMBODIMENTS

[0016] Reference will now be made in detail to the various embodiments of the disclosure, one or more examples of which are illustrated in the figures. Within the following description of the drawings, the same reference numbers refer to same components. Generally, only the differences with respect to individual embodiments are described. Each example is provided by way of explanation of the disclosure and is not meant as a limitation of the disclosure. Further, features illustrated or described as part of one embodiment can be used on, or in conjunction with, other embodiments to yield yet a further embodiment. It is intended that the description includes such modifications and variations.

[0017] An apparatus for transportation of a carrier in a vacuum chamber can provide one, two or more transport paths, wherein the carrier can be moved or conveyed along the transport paths. A first transport path T1 may extend next to a second transport path T2, e.g., essentially parallel to the first transport path T1. The first transport path T1 and/or the second transport path T2 may extend in a transport direction T which may be an essentially horizontal direction.

[0018] The first transport path T1 and the second transport path T2 may be horizontally offset from each other in a path switch direction S. The distance between the first transport path T1 and the second transport path T2 in the path switch direction S may be 10 cm or more, particularly 20 cm or more, and/or 100 cm or less, particularly 50 cm or less.

[0019] The apparatus for transportation of a carrier described herein can be a part of a vacuum processing system, such as an in-line processing system, such that a substrate can be continuously or quasi-continuously processed. The apparatus may be configured to

displace or move the carrier away from the first transport path T1 to at least one of the second transport path T2 and a processing position T3 in which the substrate can be processed. Specifically, the apparatus can laterally displace the carrier from a first position on the first transport path T1 to a second position away from the first track in the path switch direction S. The path switch direction S may be transverse to the transport direction T, particularly essentially perpendicular to the transport direction T. When the carrier is moved from one transport path to another transport path in a path switch direction S, said movement can also be referred to as “path switch” or a “track switch”.

[0020] In some embodiments, a carrier is transported along the first transport path T1 in the transport direction T, moved away from the first transport path T1 in the path switch direction S to a processing position T3 where the substrate is processed, moved in the path switch direction S to the second transport path T2, and transported along the second transport path T2.

[0021] The apparatus may include a transport system. The transport system may be configured for a contactless transportation of the carrier along the first and/or second transport path, e.g. using a magnetic force. In other words, the transport system may not use a mechanical force to transport the carrier. Instead, the transport system may magnetically push or pull the carrier towards a new position. The terms “contactless” and “contactlessly moving” as used throughout the present disclosure can be understood in the sense that the carrier is not moved using a mechanical contact between the carrier and the transport system, but is magnetically moved by a repulsive and/or an attractive magnetic force. In some implementations, there is no mechanical contact between the apparatus and the carrier at all during the transportation along the first and/or second transport path.

[0022] The transport system may be a magnetic levitation system in some embodiments. The magnetic levitation system may include an upper track and a lower track, wherein the carrier may be transported in an essentially vertical orientation between the upper track and the lower track. The upper track may be arranged above the lower tracks. Magnets and/or drive units of the magnetic levitation system may be arranged at the upper track and/or at the lower track. For example, active magnetic units configured to contactlessly hold the carrier below the upper track may be arranged at the upper track, and drive units configured to move the carrier along the tracks may be arranged at the lower track.

[0023] The contactless transport of the carrier is beneficial in that a reduced number of particles are generated due to a mechanical contact between the carrier and sections of the transport system, such as rollers, during the transport of the carrier. Accordingly, the vacuum conditions in the vacuum chamber are not negatively affected by the transport of the carrier. A purity of the layers deposited on the substrate can be improved, in particular since the particle generation is minimized or even avoided when using the transport system configured for a contactless transport.

[0024] FIG. 1A is a schematic view of an apparatus 100 for transporting a carrier 10 in a vacuum chamber 101 in a transport position (I) according to embodiments described herein. In the transport position (I), the carrier 10 can be transported along the first transport path T1 in a transport direction T. During a contactless transport, a (small) gap may be provided between the carrier and an upper track section and between the carrier and a lower track section.

[0025] FIG. 1B is a schematic view of the apparatus of FIG. 1A in a path switch position (II). In the path switch position (II), the carrier 10 can be moved away from the first transport path T1 in the path switch direction S, e.g. toward the second transport path T2. According to some embodiments, the apparatus 100 can be a part of a vacuum processing system, for example, a sputter deposition system or an evaporation deposition system.

[0026] The carrier 10 can be a substrate carrier configured to carry a substrate 11. For example, the carrier 10 may include a chucking device, e.g., a magnetic chuck or an electrostatic chuck for chucking the substrate 11 toward a holding surface of the carrier 10. In other embodiments, the carrier may be configured to carry a different object, e.g. a mask or a shield. The carrier 10 may be configured to hold the substrate 11 in an essentially vertical orientation. In other words, an angle between a main surface of the substrate 11 and the gravity vector is typically less than 20° during the transport of the carrier 10. For example, the angle between the main surface of the substrate and the gravity vector may be from -10° to $+10^\circ$, particularly from -1° to -5° , wherein negative angles are meant to designate downwardly facing substrates.

[0027] The carrier may be configured to carry a large-area substrate, particularly a large-area substrate for display manufacturing. In embodiments, the substrate may have a surface

area to be processed of 1 m² or more, particularly 5 m² or more, or even 10 m² or more. Accordingly, the carrier may have a substrate holding surface having a size of 1 m² or more, particularly 5 m² or more, or even 10 m² or more. For example, the height of the carrier 10 may be 1 m or more, particularly 2 m or more, and/or a width of the carrier may be 1 m or more, particularly 2 m or more. The carrier 10 may be configured for carrying the substrate in an essentially vertical orientation.

[0028] The apparatus 100 includes a first transport system 112 configured to transport the carrier 10 along the first transport path T1 in the transport direction T, particularly a transport system configured for a contactless transport of the carrier. The first transport system 112 may be a first magnetic levitation system configured for a contactless transport of the carrier along the first transport path T1. The first transport system 112 includes a lower track section 121 and an upper track section 122. The carrier may be transported in a carrier transportation space between the lower track section 121 and the upper track section 122. Magnetic units of the first transport system 112 may be arranged at the lower track section 121 and/or at the upper track section 122. For example, a plurality of actively controlled magnetic units may be arranged at the upper track section 122 for contactlessly holding the carrier 10 below the upper track section 122.

[0029] The apparatus 100 further includes a path switch assembly 150. The path switch assembly 150 may be configured to move the carrier away from the first transport path T1 in the path switch direction S. In particular, the path switch assembly 150 may be configured to move the carrier from the first transport path T1 to the second transport path T2 in the path switch direction S essentially perpendicular to the transport direction T. Alternatively or additionally, the path switch assembly 150 may be configured to move the carrier to a processing position T3 in which the carrier is processed, e.g. coated. The process position T3 may be horizontally offset from the first and second transport paths.

[0030] As is schematically depicted in FIG. 1A and in FIG. 1B, a processing tool 105 may be arranged in the vacuum chamber for processing the substrate 11 held by the carrier 10 when the carrier is arranged in the processing position T3. The processing tool 105 can be a deposition source configured to deposit a coating material on the substrate.

[0031] The apparatus 100 further includes an actuator 125 for switching between the transport position (I) that is depicted in FIG. 1A and the path switch position (II) that is depicted in FIG. 1B. In the transport position (I), the lower track section 121 and the upper track section 122 are arranged at a first distance from each other, and, in the path switch position (II), the lower track section 121 and the upper track section 122 are arranged at a second distance from each other. The first distance is smaller than the second distance.

[0032] In other words, according to embodiments described herein, the distance between the lower track section 121 and the upper track section 122 of the first transport system 112 can be adjusted, particularly increased and/or decreased. The first distance (small distance) may be suitable for contactlessly transporting the carrier between the lower track section 121 and the upper track section 122 in the transport direction. Moving the carrier away from the first transport path T1 in the path switch direction may be difficult, when the lower and upper track sections are provided at a small relative distance. A second distance (large distance) between the lower track section 121 and the upper track section 122 may be suitable for moving the carrier away from the first transport path, i.e. to the second transport path T2 and/or to the processing position T3 in the path switch direction.

[0033] In some embodiments, the first distance between the lower track section 121 and the upper track section 122 may be 1 m or more, particularly 2 m or more. For example, the first distance may be slightly larger than a vertical dimension of the carrier, such that the carrier can be contactlessly transported between the lower track section and the upper track section. The second distance may be several millimeters or centimeters larger than the first distance. In particular, a difference between the first distance and the second distance may be 5 mm or more, 20 mm or more, 40 mm or more, or even 100 mm or more. In other words, the actuator 125 may be configured for changing the distance between the lower track section and the upper track section by 5 mm or more, 20 mm or more, 40 mm or more, or even 100 mm or more.

[0034] In other words, an actuator 125 may be provided for increasing the distance between the lower track section 121 and the upper track section 122 along a portion of the first transport path T1 where the path switch assembly 150 is arranged. The actuator may include a drive device, e.g. a motor, a hydraulic device or a pneumatic device for increasing the distance between the lower track section 121 and the upper track section

122. In some embodiments, the actuator 125 may be configured to move the lower track section 121 away from the upper track section 122, e.g. in a vertical direction, and particularly in a downward direction, in order to increase the distance between the upper track section 122 and the lower track section 121. In some embodiments, the actuator 125 may be configured to move the upper track section 122 away from the lower track section 121, e.g. in a vertical direction, particularly in an upward direction, in order to increase the distance between the upper track section 122 and the lower track section 121.

[0035] A path switch of the carrier away from the first transport path T1 may include transporting the carrier along the first transport path in the transport direction T, while the first transport system 112 is provided in the transport position (I) depicted in FIG. 1A. The carrier may be stopped, and the first transport system 112 may be moved to the path switch position (II) depicted in FIG. 1B, with a larger distance between the upper track section and the lower track section. Thereupon, the carrier may be moved away from the first transport path T1 in the path switch direction S.

[0036] Moving the carrier away from the first transport path T1 in the path switch direction S may be easier in the path switch position for several reasons. For example, the magnetic force effect of permanent magnets, which may act on the carrier from the upper and lower track sections, may be reduced by moving the upper and lower track sections away from each other. Further, in the path switch position (II), side guiding rails connected to the upper and/or lower track sections may not interfere with the carrier. Further, in the path switch position, a larger space is provided between the upper track section and the lower track section such that a sideways transfer of the carrier by the path switch assembly can be facilitated and a more compact path switch assembly can be provided. Contacts between the carrier and the tracks during the path switch can be avoided.

[0037] In some embodiments, switching between the transport position (I) depicted in FIG. 1A and the path switch position (II) depicted in FIG. 1B may include moving the lower track section 121 in a downward direction using the actuator. For example, the lower track section 121 may be moved downward by a distance of 20 mm or more, particularly 40 mm or more, more particularly 80 mm or more. The vertical space between the lower track section 121 and the upper track section 122 can be increased for facilitating the path switch movement.

[0038] In some embodiments, which may be combined with other embodiments described herein, the path switch assembly 150 includes a carrier holding portion 152 movable in the path switch direction S for transferring the carrier 10 held by the carrier holding portion 152 in the path switch direction S. For example, the carrier 10 may be mechanically supported on the carrier holding portion 152. In the embodiment depicted in FIG. 1B, the carrier 10 is supported by the carrier holding portion 152 from below, i.e. the carrier 10 can be placed on top of the carrier holding portion 152. In other embodiments, the carrier holding portion may hold the carrier from the side or from above. For example, the carrier holding portion 152 may include a magnetic chuck for chucking the carrier to the carrier holding portion 152.

[0039] A drive device (also referred to herein as a “cross drive”) may be provided for moving the carrier holding portion 152 in the path switch direction S for transferring the carrier from the first transport path T1 to at least one of the second transport path T2 and the processing position T3. The drive device (not depicted in the figures) may be arranged outside the vacuum chamber 101, and the carrier holding portion 152 may extend through a wall of the vacuum chamber 101. Alternatively, the drive device may be arranged inside the vacuum chamber 101.

[0040] The drive device may be configured to move the carrier holding portion 152 in the path switch direction S by a distance of 10 cm or more, particularly 20 cm or more, from the first transport path T1 to the second transport path T2. For example, a distance between the first transport path T1 and the second transport path T2 may be 25 cm or more and 100 cm or less.

[0041] The carrier holding portion 152 of the embodiment depicted in FIG. 1B includes a carrier support surface for positioning the carrier on the carrier support surface. For example, the carrier 10 may be moved in a downward direction by the lower track section 121 and be positioned on the support surface of the carrier holding portion 152. Thereupon, the path switch assembly 150 may move the carrier holding portion 152 in the path switch direction S for transferring the carrier away from the first transport path T1.

[0042] In some embodiments, which may be combined with other embodiments described herein, a second transport system 114 may be provided for transporting the

carrier 10 along a second transport path T2. The second transport system 114 may be a second magnetic levitation system provided along the second transport path T2. The second transport path T2 may be horizontally offset from the first transport path T1. The path switch assembly 150 may be movable in the path switch direction S from the first transport path T1 to at least one of the second transport path T2 and the processing position T3.

[0043] In particular, the carrier holding portion 152 of the path switch assembly 150 may be movable in the path switch direction S for transferring the carrier 10 from the first transport path T1 to the second transport path T3 and/or to the processing position T3 which is horizontally offset from both the first and second transport paths.

[0044] Similar to the first transport system 112, the second transport system 114 may include a second lower track section 123 and a second upper track section 124, wherein the carrier can be transported along the second transport path T2 between the second lower track section 123 and the second upper track section 124.

[0045] In some embodiments, an actuator may be provided for increasing and/or decreasing the distance between the second lower track section 123 and the second upper track section 124. In some embodiments, one single actuator (e.g. the actuator 125) may be provided for increasing and/or decreasing both the distance between the lower track section 121 and the upper track section 122 of the first transport system 112 and the distance between the second lower track section 123 and the second upper track section 124 of the second transport system 114. In other embodiments, a first actuator may be provided for increasing and/or decreasing the distance between the lower track section 121 and the upper track section 122 of the first transport system 112, and a second actuator may be provided for increasing and/or decreasing the distance between the second lower track section 123 and the second upper track section 124 of the second transport system 114.

[0046] In particular, in some embodiments, the second lower track section 123 of the second transport system 114 may be movable in a vertical direction V, particularly in a downward direction to a path switch position (II) and in an upward direction to a transport position (I).

[0047] In some embodiments, which may be configured with other embodiments described herein, the lower track section 121 of the first transport system 112 is movable in a vertical direction V independently of the second lower track section 123 of the second transport system 114. FIG. 1A shows the lower track section 121 and the second lower track section 123 in an upper position corresponding to a transport position (I) in which a transport of the carrier along the first and second transport paths is possible. FIG. 1B shows the lower track section 121 and the second lower track section 123 in a lower position corresponding to a path switch position (II) in which a path switch between the transport paths is possible.

[0048] As is schematically depicted in FIG. 1A, in the transport position (I), an upper side guide 141 and/or a lower side guide 142 of the second magnetic levitation system may prevent a path switch of the carrier from the first transport path T1 toward the second transport path T2. After switching to the path switch position (II) depicted in FIG. 1B, the carrier can be moved past the upper side guide 141 and past the lower side guide 142 in the path switch direction S due to the increased distances between the upper and lower track sections.

[0049] FIG. 2 shows a schematic top view of a system 200 including an apparatus for transportation of a carrier according to embodiments described herein. The apparatus may correspond to the apparatus 100 depicted in FIG. 1A and FIG. 1B, such that reference can be made to the above explanations, which are not repeated here.

[0050] The system 200 for vacuum processing of a substrate according to embodiments described herein includes a vacuum chamber 101, the apparatus 100 according to any of the embodiments described herein, and one or more processing tools 105 arranged in the vacuum chamber 101. The one or more processing tools may be selected from the group consisting of deposition sources, sputter sources, evaporation sources, surface treatment tools, heating devices, cleaning devices, etching tools, and combinations thereof.

[0051] A first transport path T1 and a second transport path T2 which is horizontally offset from the first transport path T1 extend through the vacuum chamber 101. Optionally, a processing position T3 in which a substrate can be processed is provided horizontally offset from the first transport path T1 and the second transport path T2. In some

embodiments, a mask 12 is provided between the processing position T3 of the carrier 10 and the processing tool 105. The mask 12 may be, e.g., an edge exclusion mask or a fine metal mask. For example, the mask 12 may prevent a portion of the substrate from being coated and/or the mask may have an opening pattern corresponding to a material pattern to be deposited on the substrate.

[0052] The apparatus 100 includes a first transport system 112 for contactlessly transporting the carrier 10 along the first transport path T1, a second transport system 114 for contactlessly transporting the carrier 10 along the second transport path T2, and a path switch assembly 150 configured to transfer the carrier 10 from the first transport path T1 to the second transport path T2 and/or to the processing position T3 in the path switch direction S. The path switch assembly 150 may include a carrier holding portion 152 configured to hold and/or support the carrier 10 which is movable in the path switch direction S.

[0053] The first transport system 112 may include a lower track section 121 (schematically indicated as a dashed line in FIG. 2), and an actuator configured to move the lower track section 121 in a vertical direction. The length of the lower track section 121 in the transport direction T may be equal to or larger than the length of the carrier 10 in the transport direction T. The lower track section 121 may be provided along a section of the first transport path where the path switch assembly 150 is arranged. Accordingly, the lower track section 121 can be moved in a downward direction for enabling the path switch assembly to transfer the carrier 10 away from the first transport path T1 in the path switch direction S.

[0054] In some embodiments, The second transport system 114 may include a second lower track section 123 (schematically indicated as a dashed line in FIG. 2), and an actuator configured to move the second lower track section 123 in a vertical direction. The length of the second lower track section 123 in the transport direction T may be equal to or larger than the length of the carrier 10 in the transport direction T. The second lower track section 123 may extend along a section of the second transport path where the path switch assembly 150 is arranged. Accordingly, the second lower track section 123 can be moved in a downward direction for enabling the path switch assembly to transfer the carrier 10

onto the second transport path T2 or across the second transport path T2 in the path switch direction S.

[0055] FIGS. 3A-H show various stages of a method for transportation of a carrier with an apparatus 300 according to embodiments described herein. The apparatus 300 may be similar to the apparatus 100 depicted in FIG. 1A and FIG. 1B, such that reference can be made to the above explanations which are not repeated here.

[0056] The apparatus 300 includes a first transport system 112 for a contactless transport of a carrier 10 along the first transport path T1, and a second transport system 114 for a contactless transport of the carrier 10 along the second transport path T2 horizontally offset from the first transport path T1.

[0057] Further, a path switch assembly 150 is provided for transferring the carrier 10 from the first transport path T1 to the second transport path T2 and/or to the processing position T3. The processing position T3 is only depicted in FIG. 3E and is optional. In other words, instead of transferring the carrier from the first transport path T1 to the processing position T3 and then to the second transport path T2, it is likewise possible to transfer the carrier from the first transport path directly to the second transport path in the path switch direction. Alternatively, instead of transferring the carrier to the second transport path T2, the carrier may be transferred from the processing position T3 depicted in FIG. 3E back to the first transport path T1.

[0058] The path switch assembly 150 may include a carrier holding portion 152 configured to hold and/or support the carrier, wherein the carrier holding portion 152 may be movable in the path switch direction S together with the carrier. The path switch assembly is configured to move the carrier in the path switch direction S.

[0059] The first transport system 112 includes a lower track section 121 which may be movable in a vertical direction V, and/or the second transport system 114 may include a second lower track section 123 which may be movable in the vertical direction V. The lower track section 121 and the second lower track section 123 may be arranged next to and parallel to each other, such that a carrier can be transferred between the lower track section 121 and the second lower track section 123 in the path switch direction S,

particularly without changing the orientation of the carrier 10. In other words, during the path switch, the carrier may maintain an essentially vertical orientation aligned along the transport direction T.

[0060] In FIG. 3A, a carrier is transported by the first transport system 112 along the first transport path T1 in the transport direction T. The transport may be a contactless transport. In other words, the carrier 10 may be held at a distance (e.g., a distance of about 2 mm) above the lower track section 121 by magnetic forces, e.g. repulsive magnetic forces acting from below and/or attractive magnetic forces acting from above. In FIG. 3A, a transport position (I) is shown that is configured for the contactless transport along the first transport path T1, wherein a first distance is provided between the lower track section 121 and an upper track section 122 of the first transport system 112.

[0061] The carrier 10 is transported to a position along the first transport path T1 depicted in FIG. 3A where the path switch assembly 150 is arranged.

[0062] In some embodiments, which may be combined with other embodiments, the path switch assembly 150 comprises an upper holding device 154 configured to hold and/or stabilize an upper portion of the carrier 10. The upper holding device 154 may be movable in the path switch direction S. The upper holding device 154 may optionally also be movable in a vertical direction V. The upper holding device 154 may be configured to prevent a tilting movement of the carrier when the magnetic levitation is switched off.

[0063] In some embodiments, the upper holding device 154 may be configured to contact an upper end portion of the carrier 10 and/or may be movable in the vertical direction V into contact with an upper end portion of the carrier 10. For example, the upper holding device 154 may include fingers or other holding devices configured to contact and grasp the carrier from above. In particular, the upper holding device 154 may include spring mounted fingers configured to hold and/or stabilize the carrier when the magnetic levitation provided by the first transport system 112 is switched off. For example, a side stabilization in the path switch direction S may be provided by the upper holding device 154. As is schematically indicated in FIG. 3B, the upper holding device 154 provides a side stabilization of the carrier in the path switch direction and prevents a tipping movement.

[0064] In some embodiments, the magnetic levitation force of the first transport system 112 may be reduced or switched off, such that the carrier 10 comes into mechanical contact with the lower track section 121 and is supported on the lower track section 121. For example, the carrier can be smoothly placed on the lower track section 121 by gradually
5 reducing the magnetic levitation force of the first magnetic levitation system.

[0065] A reduction of the magnetic levitation force provided by the first transport system 112 in order to position the carrier on the lower track section 121 is depicted in more detail in FIG. 4A and FIG. 4B. In FIG. 4A, the carrier is contactlessly held at a distance above the lower track section 121 by the first transport system 112. For example, active magnetic
10 units 301 arranged at the upper track section 122 may contactlessly hold the carrier 10 at a distance above the lower track section 121. In FIG. 4B, an upper portion of the carrier is stabilized by the upper holding device 154, and the magnetic levitation force is reduced or switched off for placing the carrier on a substrate support surface of the lower track section 121. The lower track section 121 may then be lowered.

[0066] According to a further aspect of the present disclosure, which may be made the subject of an independent claim, the actuator 125 is configured to lower the lower track section 121 with the carrier 10 supported thereon for placing the carrier on the carrier holding portion 152 of the path switch assembly.

[0067] Returning to FIG. 3B, the actuator may be configured to move the lower track section 121 in a downward direction away from the upper track section 122 such that the
20 distance between the lower track section 121 and the upper track section 122 is increased. The carrier 10 that is supported on the lower track section 121 is lowered toward the carrier holding portion 152 until the carrier is placed on the carrier holding portion 152. For example, the lower track section 121 may be lowered from a first level L1 down to the
25 level of the carrier holding portion 152 by a distance of 20 mm or more, particularly 40 mm or more.

[0068] As is schematically depicted in in FIG. 3B and FIG. 3C, the lower track section 121 and the carrier holding portion 152 of the path switch assembly 150 may be configured to support the carrier 10 from below. In other words, the bottom surface of the carrier 10

may first be placed on the lower track section 121 (FIG. 3B) and then on the carrier holding portion 152 (FIG. 3C).

[0069] As is further depicted in FIG. 3B, the lower track section 121 with the carrier supported thereon may be moved in the downward direction away from the upper track section 122 until the carrier 10 is positioned on the carrier holding portion 152. The lower track section may continue with the downward movement until the lower track section 121 is positioned at a second level L2, e.g., below the level of the carrier holding portion 152, as is schematically depicted in FIG. 3C. The distance between the first level L1 and the second level L2 may be 40 mm or more, particularly 80 mm or more. Accordingly, the difference between the first distance (i.e. the distance between the lower track section 121 and the upper track section 122 in the transport position (I)) and the second distance (i.e. the distance between the lower track section 121 and the upper track section 122 in the path switch position (II)) may be 40 mm or more, particularly 80 mm or more.

[0070] According to some embodiments, which can be combined with other embodiments described herein, the first transport system 112 is a magnetic levitation system configured to contactlessly hold the carrier above the lower track section 121 in the transport position (I), particularly via magnetic forces acting on the carrier. Further, the lower track section 121 may include a carrier support for mechanically supporting the carrier from below. In particular, during the contactless transport, the carrier may contactlessly float above the lower track section, and, during the path switch, the carrier may be in contact with the lower track section and supported on the lower track section.

[0071] Due to the downward movement of the carrier 10 supported on the lower track section 121, a distance between the carrier 10 and the upper track section 122 can be increased. Due to the downward movement of the lower track section 121 relative to the carrier 10 supported by the carrier holding portion 152, a distance between the carrier and the lower track section 121 can be increased. Accordingly, a transfer movement of the carrier in the path switch direction S can be facilitated because the free space above the carrier 10 and below the carrier during the path switch can be increased.

[0072] As is schematically depicted in FIG. 3D and in FIG. 3E, the carrier holding portion 152 with the carrier 10 supported thereon may be moved in the path switch

direction S from the first transport path T1 to the second transport path T2 (FIG. 3D) and/or to the processing position (FIG. 3E) where the substrate may be processed by the processing tool 105.

[0073] In some embodiments, which can be combined with other embodiments described herein, the carrier 10 is transferred to the second transport path T2. In some embodiments, the second transport system 114 provided along the second transport path T2 may include a second lower track section 123 that is movable in a vertical direction.

[0074] As is schematically depicted in FIG. 3F, the second lower track section 123 may be moved from a path switch position in an upward direction until the carrier comes into contact with the second lower track section 123 and is lifted up from the carrier holding portion 152 by the second lower track section 123. For example, the second lower track section 123 may be moved in the upward direction from a second level L2 below the level of the carrier holding portion 152 to a first level L1 above the level of the carrier holding portion 152.

[0075] By moving the second lower track section 123 in the upward direction, as is schematically depicted in FIG. 3G, a distance between the second lower track section 123 and a second upper track section 124 of the second transport system 114 can be decreased, until the transport position (I) is reached. The transport position (I) is depicted in FIG. 3H.

[0076] In the transport position (I) depicted in FIG. 3H, the magnetic levitation of the second transport system 114 can be switched on to contactlessly hold the carrier between the second lower track section 123 and the second upper track section 124. The carrier can then be contactlessly transported along the second transport path T2, e.g. in the transport direction T.

[0077] The carrier holding portion 152 of the path switch assembly 150 can be moved back toward the first transport path T1 in the path switch direction S, whereupon a path switch may be performed on a second carrier.

[0078] FIGS. 5A-D show various stages of a method for transportation of a carrier with an apparatus 400 according to embodiments described herein. The apparatus 400 may be

similar to the apparatus 300 depicted in FIGS 3A-H, such that reference can be made to the above explanations which are not repeated here.

[0079] The apparatus 400 of FIG. 4A includes a path switch assembly 150 configured to transfer the carrier 10 from the first transport path T1 to the second transport path T2 and/or to the processing position T3, while maintaining an essentially constant orientation of the carrier 10.

[0080] The path switch assembly 150 may include a carrier holding portion 152 movable in the path switch direction S and an upper holding device 154 movable in the path switch direction S.

[0081] In some embodiments, which may be combined with other embodiments described herein, the upper holding device 154 is configured to hold and/or stabilize an upper portion of the carrier 10, particularly when a magnetic levitation force of the magnetic levitation systems is reduced or switched off. An “upper portion of the carrier” may be understood as an upper part of a vertically oriented carrier, including the upper 50%, particularly as the upper 20% of the vertically oriented carrier. In particular, the upper holding device may stabilize the upper end of the carrier.

[0082] The upper holding device 154 may stabilize the carrier in the path switch direction S, e.g. by applying oppositely directed stabilization forces on two opposite sides of the carrier.

[0083] The upper holding device 154 may include at least one magnet unit for exerting a repulsive magnetic force on the upper portion of the carrier in the path switch direction S. In some embodiments, which may be combined with other embodiments described herein, the upper holding device 154 includes a first magnet unit 302 for exerting repulsive magnetic force on the upper portion of the carrier 10 from a first side and a second magnet unit 304 for exerting a repulsive magnetic force on the upper portion of the carrier 10 from a second side opposite the first side.

[0084] Magnetic counter-units may be fixed to the upper part of the carrier 10 such as to magnetically interact with the first magnet unit 302 and the second magnet unit 304, respectively. In particular, the first magnet unit 302 of the upper holding device 154 may

exert a repulsive magnetic force on a first magnetic counter-unit fixed to a first side of the carrier, and/or the second magnet unit 304 of the upper holding device 154 may exert a repulsive magnetic force on a second magnetic counter-unit fixed to a second side of the carrier opposite to the first side. The carrier may be contactlessly stabilized in a center area
5 between the first magnet unit 302 and the second magnet unit 304.

[0085] The upper holding device 154 may be movable in the path switch direction S together with and synchronously with the carrier holding portion 152, e.g. for transferring the carrier between the tracks.

[0086] In some embodiments, the upper holding device 154 may include a first arm 311
10 and a second arm 312, wherein the first arm 311 may be movable independently from the second arm 312 in the path switch direction S. For example, a first side stabilization unit such as the first magnet unit 302 may be fixed to the first arm 311, and a second side stabilization unit such as the second magnet unit 304 may be fixed to the second arm 312. Before switching off the magnetic levitation of the carrier, the first arm 311 may be moved
15 toward the carrier from a first side, and the second arm 312 may be moved toward the carrier from the second side, in order to stabilize the carrier between the first arm and the second arm.

[0087] In particular, the upper holding device 154 may be movable in the path switch direction S such that the upper part of the carrier can be contactlessly stabilized during a
20 path switch of the carrier.

[0088] In some embodiments, the upper holding device 154 is movable in the path switch direction S, but not in the vertical direction V. In other embodiments, the upper holding device 154 is movable in the path switch direction S and in the vertical direction V.

[0089] In some embodiments, which may be combined with other embodiments
25 described herein, the upper holding device 154 may be configured to provide a side stabilization of the carrier during a vertical movement of the carrier with respect to the upper holding device 154. For example, the upper holding device 154 may provide a side stabilization of the carrier arranged at a first vertical position relative to the upper holding device 154 and at a second vertical position relative to the upper holding device 154. The

first vertical position and the second vertical position may be vertically offset from each other by a distance of, e.g., 30 mm or more, particularly 50 mm or more. In particular, the upper holding device may provide a side stabilization for the carrier provided at a first vertical level and at a second vertical level, without vertically moving the upper holding
5 device.

[0090] In some embodiments, at least one magnet unit of the upper holding device 154 and/or at least one magnetic counter-unit of the carrier 10 may have a vertical dimension of 30 mm or more, particularly 40 mm or more, more particularly 50 mm or more. Thus, the at least one magnet unit may magnetically interact with the at least one magnetic counter-
10 unit, when the magnetic-counter-unit is vertically shifted with respect to the magnet unit, e.g. by a distance of 30 mm or more.

[0091] In FIG. 5A, a carrier 10 is arranged on a first transport path T1 at a first vertical level. The first transport system 112 configured as a first magnetic levitation system stabilizes the carrier in the vertical direction and in the track-switch direction.

15 [0092] In FIG. 5B, the upper holding device 154 is moved toward the carrier in the path switch direction S from two opposite sides. The carrier can be contactlessly stabilized between the first magnet unit 302 and the second magnet unit 304 of the upper holding device 154.

[0093] The magnetic levitation of the first transport system 112 can then be switched off.

20 [0094] In FIG. 5C the carrier 10 is moved in a downward direction relative to the upper holding device to a second vertical level, e.g. by a distance of 20 mm, 40 mm or more. For example, the lower track section 121 with the carrier supported thereon may be moved in the downward direction. The upper holding device 154 is configured such that the carrier is stabilized during the vertical movement of the carrier with respect to the upper holding
25 device. For example, the first magnet unit 302 and the second magnet unit 304 may extend in the vertical direction V over a distance of 30 mm or more, particularly 40 mm or more.

[0095] The carrier 10 can then be moved in the path switch direction S, e.g. by moving the carrier holding portion 152 together with and essentially synchronously with the upper holding device 154 in the path switch direction.

[0096] The upper holding device 154 can be moved away from the carrier, when the carrier is held and stabilized by the first or second transport system, e.g. after a path switch toward the second transport path T2 and an activation of the second magnetic levitation system.

- 5 [0097] According to a further aspect described herein, a method for transportation of a carrier in a vacuum chamber is described.

[0098] FIG. 6 is a flow diagram illustrating a first method according to embodiments described herein.

- 10 [0099] In box 610, a carrier 10 is transported along a first transport path T1 in a transport direction T. During the transport, the carrier 10 is arranged in a carrier transportation space between a lower track section 121 and an upper track section 122 of a first transport system 112. The carrier may be contactlessly transported, e.g. by a magnetic levitation system, in the carrier transportation space between the lower track section and the upper track section.

- 15 [00100] In box 620, a distance between the lower track section 121 and the upper track section 122 is increased. For example, the lower track section is moved downwardly, e.g. in a vertical direction, away from the upper track section. Alternatively or additionally, the upper track section is moved upwardly, e.g. in a vertical direction, away from the lower track section. An actuator may be provided for lowering the lower track section.

- 20 [00101] In box 630, the carrier is moved away from the first transport path T1 in a path switch direction S transverse to the transport direction T, particularly to a second transport path T2 and/or to a processing position T3. In particular, the carrier may be moved in the path switch direction S while being mechanically supported on and/or held by a carrier holding portion of a path switch assembly. The carrier holding portion may be movable in the path switch direction with the carrier supported thereon.

- 25 [00102] When the carrier is moved in the path switch direction S, a distance between a second lower track section 123 and a second upper track section 124 of a second transport system 114 may be set to a large distance. This may allow the carrier to enter the second transport path T2.

[00103] When the carrier is positioned on the second transport path T2, the distance between the second lower track section 123 and the second upper track section 124 of the second transport system 114 may be decreased allowing for a transport of the carrier along the second transport path via the second magnetic levitation system.

- 5 [00104] One or more further transport stages may be provided between the boxes 610 and 620 and/or between the boxes 620 and 630. Reference is made, e.g., to the transportation method described with reference to FIGS. 3A to 3H. The above explanations are not repeated here.

[00105] FIG. 7 is a flow diagram illustrating a second method for the transportation of a
10 carrier in a vacuum chamber according to embodiments described herein.

[00106] In box 710, a carrier 10 is contactlessly transported along a first transport path T1 in a transport direction T, particularly by a first magnetic levitation system.

[00107] Then, the carrier is moved to a second transport path T2 horizontally offset from the first transport path T1.

- 15 [00108] Moving the carrier to the second transport path includes, in box 720, lowering the carrier on the first transport path T1, in box 730, moving the carrier in a path switch direction S to the second transport path T2, and, in box 740 lifting the carrier on the second transport path T2.

[00109] In box 720, the carrier may be placed on a lower track section 121 of a first
20 transport system 112, particularly by reducing or switching off a magnetic levitation force provided by the first transport system.

[00110] The lower track section 121 with the carrier supported thereon may be moved in a downward direction. An actuator may be provided for moving the lower track section 121 in the vertical direction, particularly away from an upper track section 122 of the first
25 transport system. Accordingly, a distance between the lower track section 121 and the upper track section 122 can be increased via the actuator.

[00111] In box 720, the carrier may be lowered onto a carrier holding portion 152 of a path switch assembly 150, which moves the carrier supported thereon in the path switch

direction S. A drive device, particularly a cross drive, may be provided for moving the carrier holding portion 152 in the path switch direction S.

[00112] In box 750, a second lower track section 123 of a second transport system 114 provided along the second transport path T2 may be moved in an upward direction. The
5 second lower track section 123 may be moved in the upward direction until the carrier is lifted up from the carrier holding portion 152 and is arranged at a predetermined level above carrier holding portion 152. In particular, the second lower track section 123 may be moved toward a second upper track section of the second transport system. The distance
10 between the second lower track section and the second lower track section can be reduced accordingly.

[00113] The carrier can then be contactlessly transported along the second transport path T2.

[00114] 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
15 scope thereof, and the scope thereof is determined by the claims that follow.

CLAIMS

1. An apparatus (100) for transportation of a carrier (10) in a vacuum chamber (101), comprising:

5 a first transport system (112) provided along a first transport path (T1) in a transport direction (T) and comprising a lower track section (121) and an upper track section (122);

a path switch assembly (150) for moving the carrier away from the first transport path (T1) in a path switch direction (S); and

10 an actuator (125) for modifying a distance between the lower track section (121) and the upper track section (122).

2. The apparatus of claim 1, wherein the path switch assembly (150) comprises a carrier holding portion (152) movable in the path switch direction (S) for transferring the carrier (10) held by the carrier holding portion (152) in the path switch direction (S).

3. The apparatus of claim 2, wherein the actuator (125) is configured to lower the
15 lower track section (121) with the carrier (10) supported thereon for placing the carrier on the carrier holding portion (152).

4. The apparatus of any of claims 1 to 3, further comprising a second transport system (114) provided along a second transport path (T2) horizontally offset from the first transport path (T1), a carrier holding portion (152) of the path switch assembly (150) being
20 movable in the path switch direction (S) from the first transport path (T1) to at least one of the second transport path (T2) and a processing position T3 horizontally offset from the first and second transport paths.

5. The apparatus of claim 4, wherein the second transport system (114) comprises a second lower track section (123) that is movable in a vertical direction (V).

25 6. The apparatus of any of claims 1 to 5, wherein the actuator (125) is configured to move the lower track section (121) in a downward direction away from the upper track

section (122) and/or wherein the actuator (125) is configured to move the upper track section (122) in an upward direction away from the lower track section (121).

7. The apparatus of any of claims 1 to 6, wherein the first transport system (112) is a first magnetic levitation system configured to contactlessly hold the carrier at a distance above the lower track section (121), the lower track section (121) further comprising a carrier support for mechanically supporting the carrier on the carrier support.

8. The apparatus of any of claim 1 to 7, wherein the path switch assembly (150) comprises an upper holding device (154) configured to hold and/or stabilize an upper portion of the carrier (10), the upper holding device (154) being movable at least in the path switch direction (S).

9. The apparatus of claim 8, wherein the upper holding device (154) comprises a first magnet unit (302) for exerting repulsive magnetic force on the upper portion of the carrier (10) from a first side and a second magnet unit (304) for exerting a repulsive magnetic force on the upper portion of the carrier (10) from a second side opposite the first side.

10. The apparatus of any of claims 1 to 9, wherein the lower track section (121) and the carrier holding portion (152) of the path switch assembly (150) are configured to support the carrier (10) from below.

11. A system for vacuum processing of a substrate, comprising:

a vacuum chamber (101);

the apparatus (100) of any of claims 1 to 10; and

one or more processing tools (105) arranged in the vacuum chamber (101) selected from the group consisting of deposition sources, sputter sources, evaporation sources, surface treatment tools, heating devices, cleaning devices, etching tools, and combinations thereof.

12. A method for transportation of a carrier in a vacuum chamber, comprising:

transporting a carrier (10) along a first transport path (T1) in a transport direction (T) between a lower track section (121) and an upper track section (122) of a first transport system (112);

5 increasing a distance between the lower track section (121) and the upper track section (122); and

moving the carrier away from the first transport path (T1) in a path switch direction (S) transverse to the transport direction (T).

13. A method for transporting a carrier in a vacuum chamber, comprising:

10 transporting a carrier (10) along a first transport path (T1) in a transport direction (T); and

moving the carrier to a second transport path (T2) horizontally offset from the first transport path (T1), comprising lowering the carrier, moving the carrier in a path switch direction (S), and lifting the carrier.

14. The method of claim 13, wherein lowering the carrier (10) comprises:

15 placing the carrier on a lower track section (121) of a first transport system (112) provided along the first transport path (T1); and

moving the lower track section (121) in a downward direction.

15. The method of claim 13 or 14, wherein the carrier is lowered onto a carrier holding portion (152) of a path switch assembly (150), which moves the carrier supported thereon
20 in the path switch direction (S).

16. The method of claim 15, wherein lifting up the carrier comprises:

moving a second lower track section (123) of a second transport system (114) provided along the second transport path (T2) in an upward direction until the carrier is lifted up from the carrier holding portion (152) and is arranged at a predetermined level
25 above the carrier holding portion (152).

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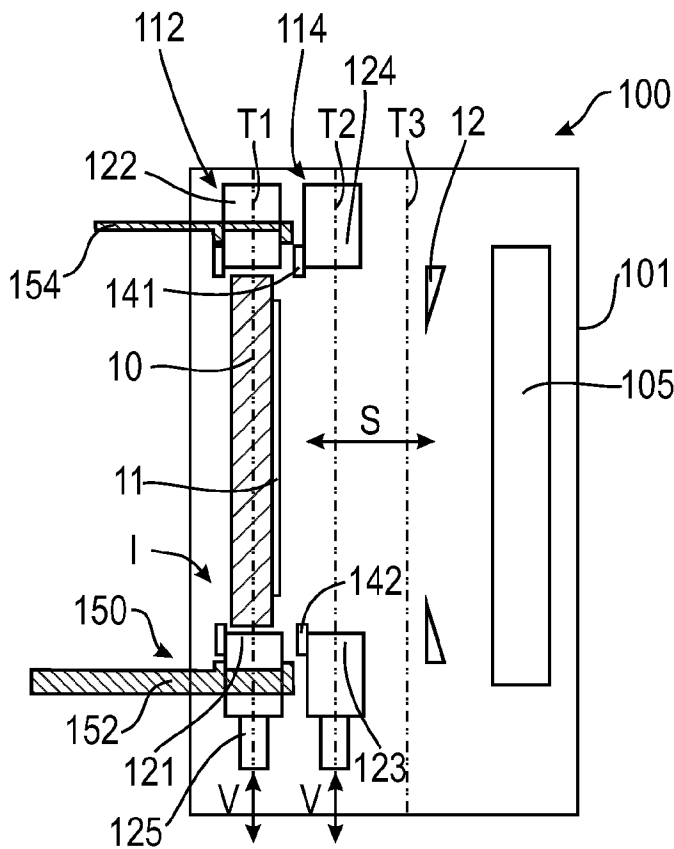


FIG. 1A

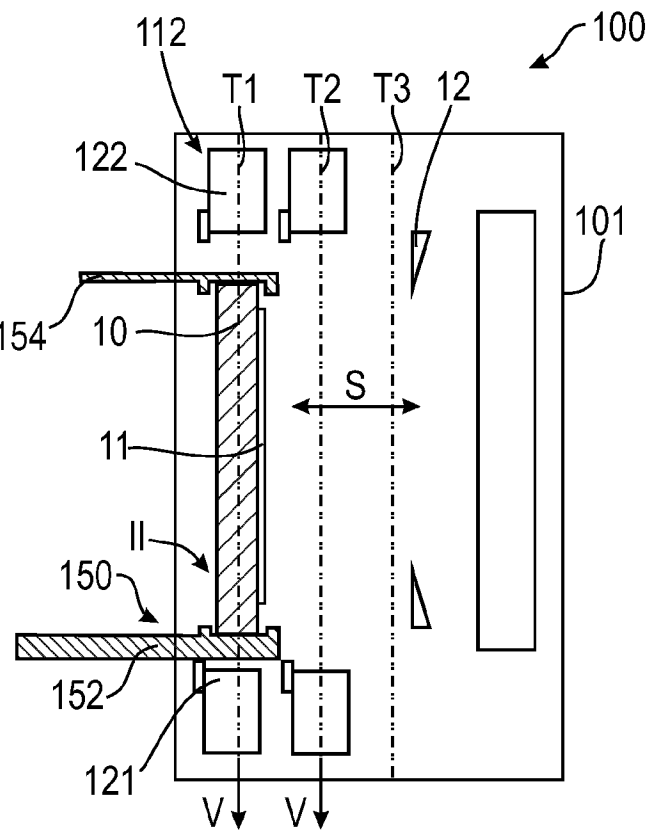


FIG. 1B

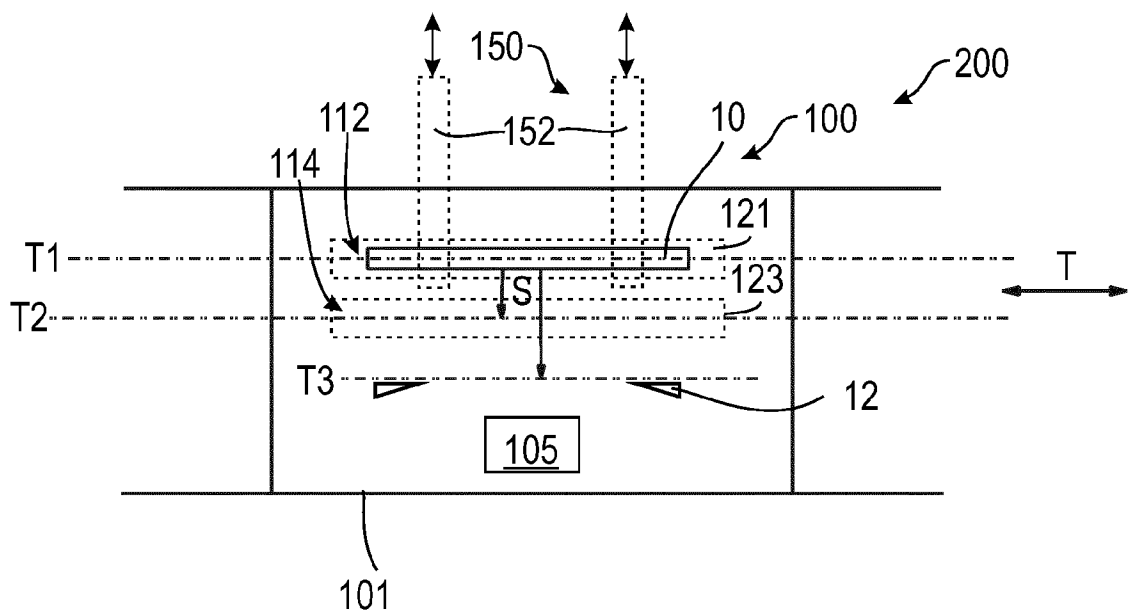


FIG. 2

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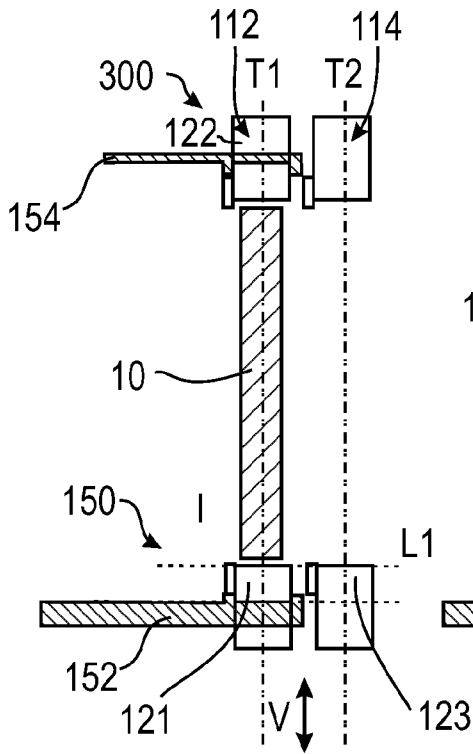


FIG. 3A

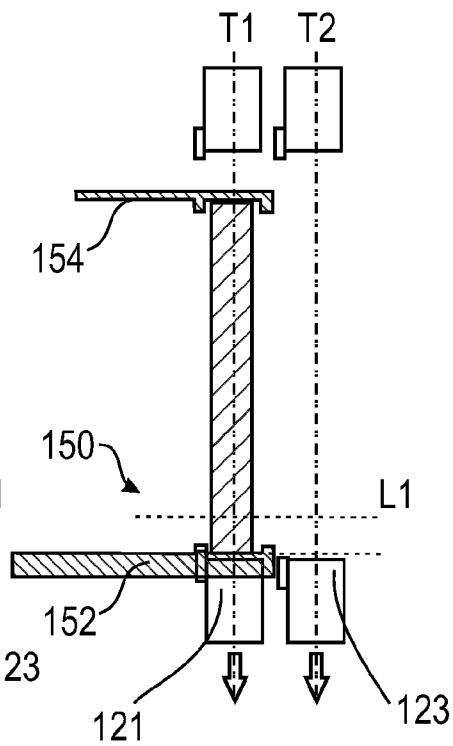


FIG. 3B

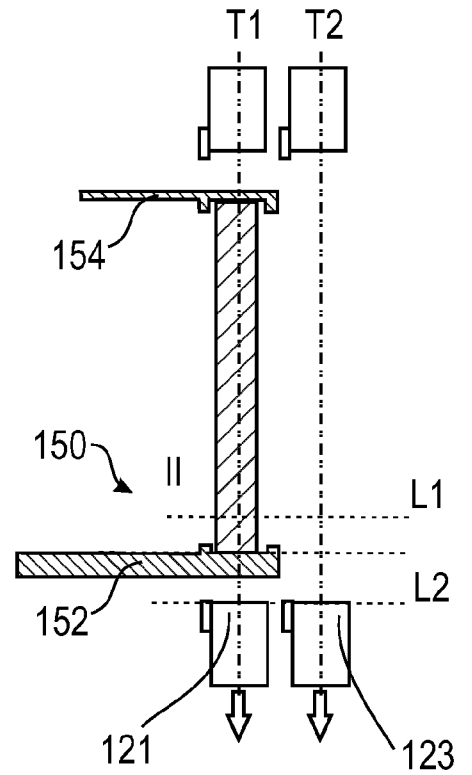


FIG. 3C

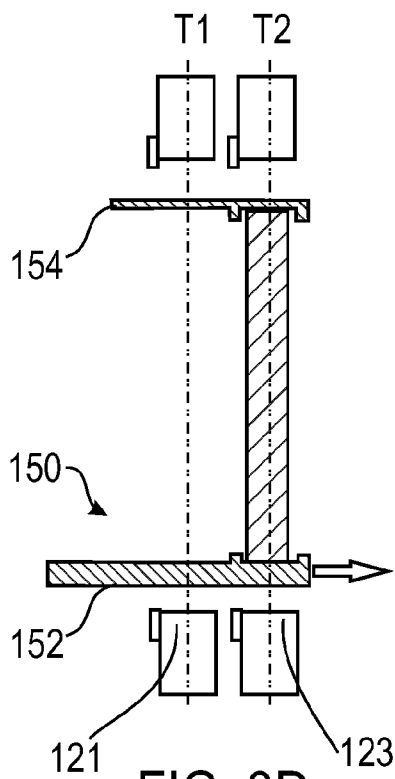


FIG. 3D

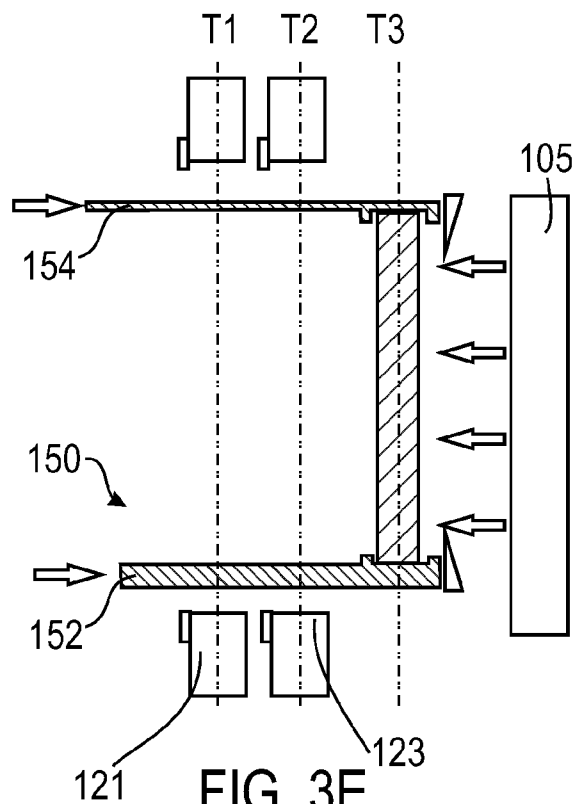


FIG. 3E

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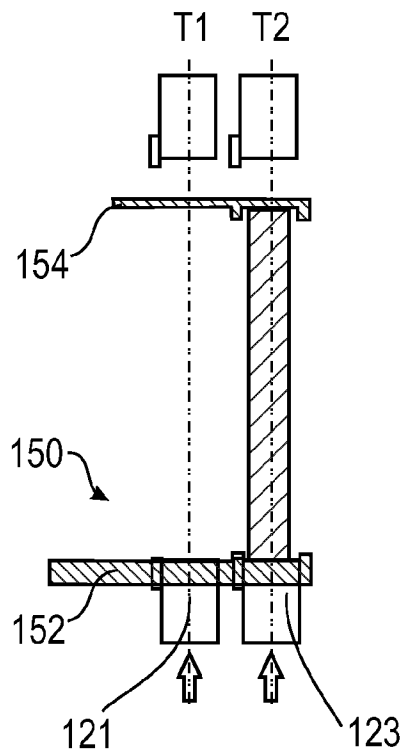


FIG. 3F

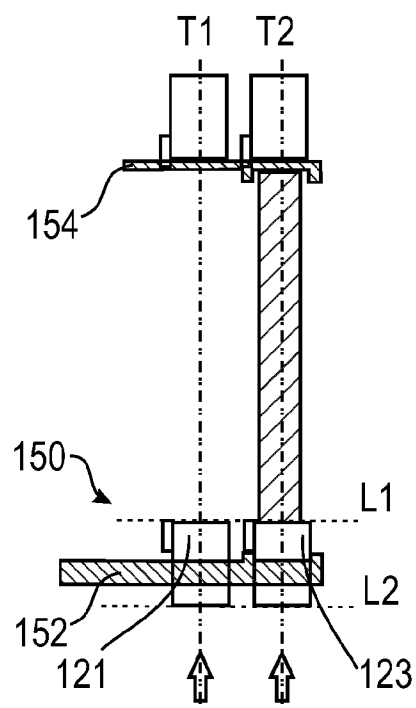


FIG. 3G

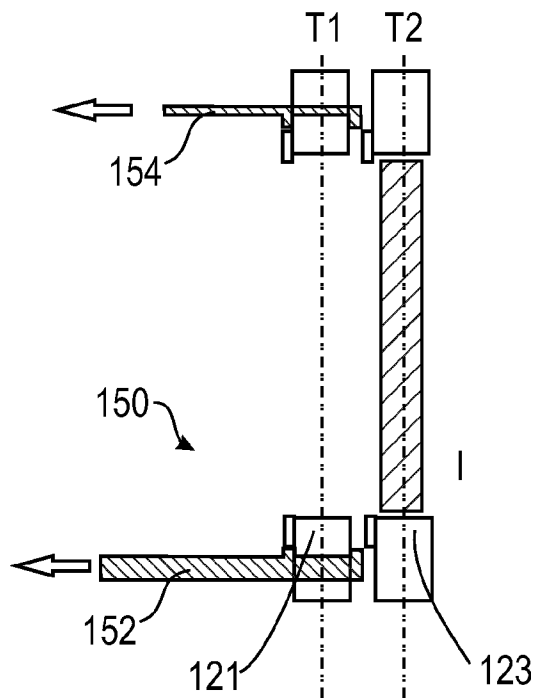


FIG. 3H

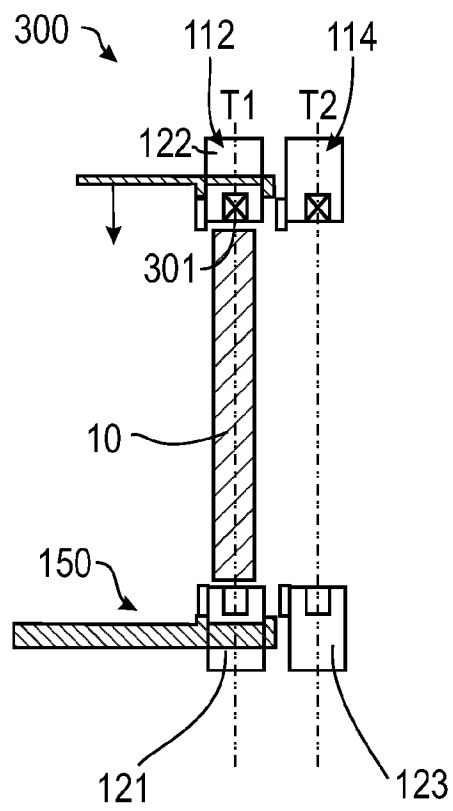


FIG. 4A

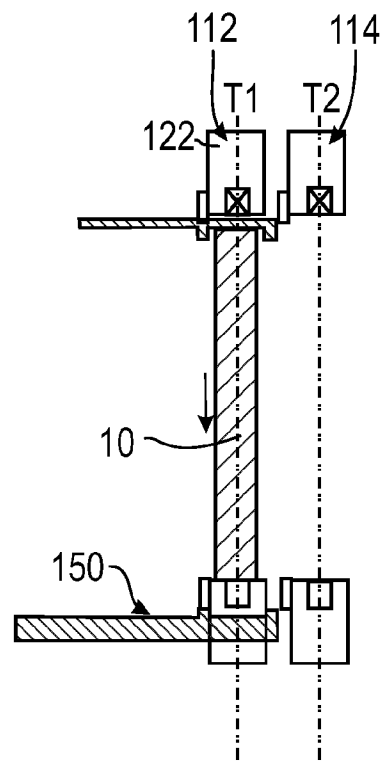


FIG. 4B

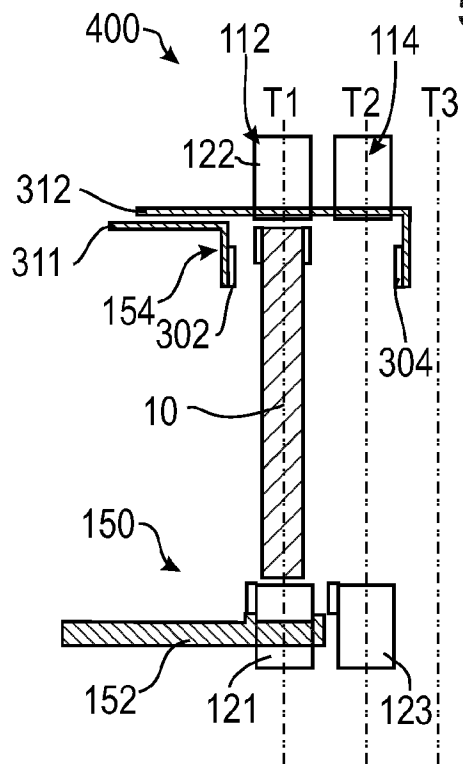


FIG. 5A

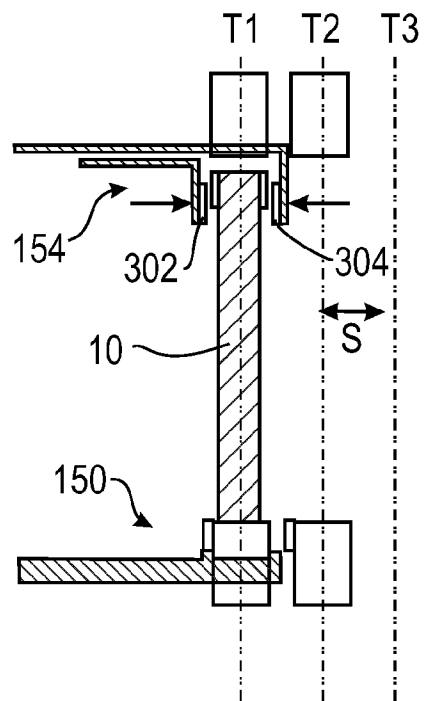


FIG. 5B

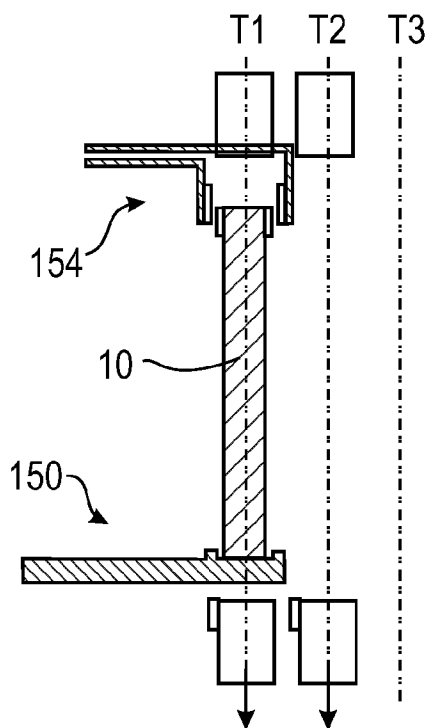


FIG. 5C

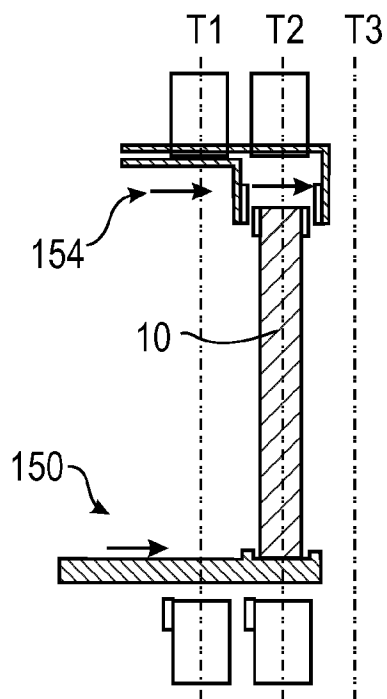


FIG. 5D

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FIG. 6

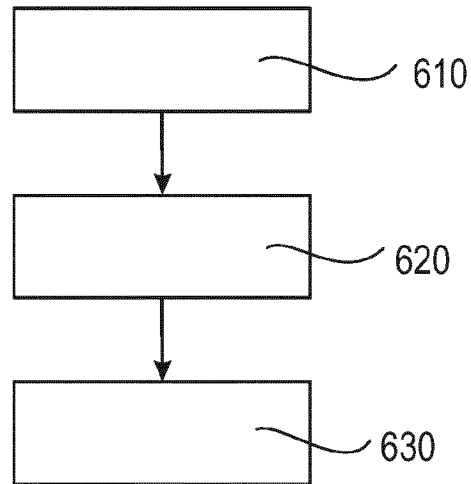
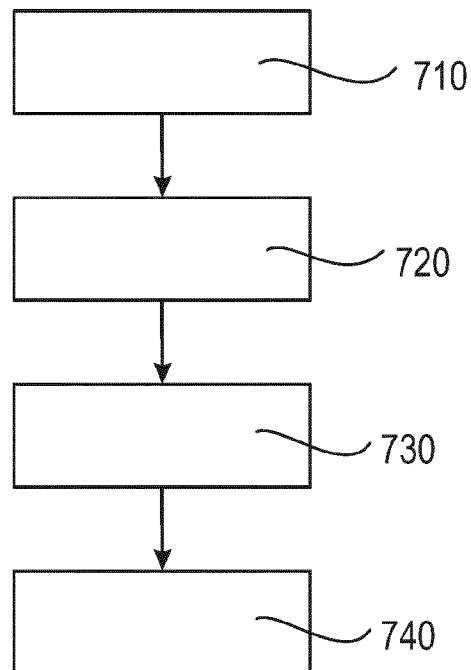


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/071447

A. CLASSIFICATION OF SUBJECT MATTER
INV. C23C14/56 C23C14/50 H01L21/677
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 H01L

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	CN 102 194 728 A (AVACO CO LTD; DAE MYUNG ENG) 21 September 2011 (2011-09-21)	1-6, 10-14
Y	paragraph [0082] - paragraph [0097]; figures 8,9 paragraph [0050]; figure 6c	7-9,15, 16
Y	----- WO 2017/125123 A1 (APPLIED MATERIALS INC [US]; LAU SIMON [DE]; BUSCHBECK WOLFGANG [DE]) 27 July 2017 (2017-07-27) claim 15	7-9
Y	----- US 2008/223693 A1 (HABERKORN EDGAR [DE] ET AL) 18 September 2008 (2008-09-18) figure 4	15,16



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/071447

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 102194728 A	21-09-2011	CN 102194728 A	21-09-2011
		KR 20110094941 A	24-08-2011
		TW 201130075 A	01-09-2011

WO 2017125123 A1	27-07-2017	TW 201727812 A	01-08-2017
		WO 2017125123 A1	27-07-2017

US 2008223693 A1	18-09-2008	AT 555496 T	15-05-2012
		CN 101270473 A	24-09-2008
		EP 1973154 A1	24-09-2008
		JP 2008254925 A	23-10-2008
		KR 20080084584 A	19-09-2008
		TW 200903691 A	16-01-2009
		US 2008223693 A1	18-09-2008
