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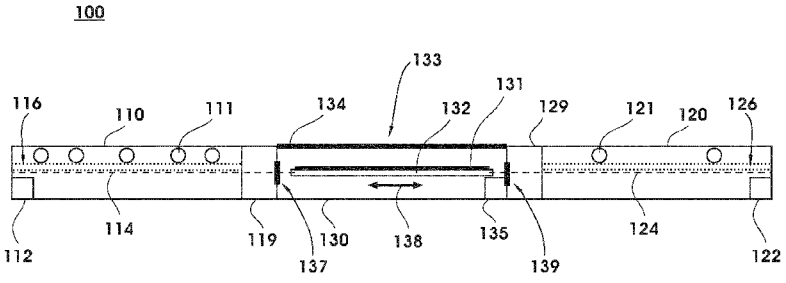


Fig. 1

(57) Abstract: According to the present disclosure, an inline substrate processing system (100) for processing an essentially vertically-oriented substrate (131) is provided. The inline substrate processing system includes a first processing chamber (110) having a first processing region (116) and being adapted to deposit a first material layer on the substrate; a second processing chamber (120) having a second processing region (126) and being adapted to deposit a second material layer on the substrate; and a loadlock chamber (130) adapted to load and unload the substrate from the inline substrate processing system. The loadlock chamber is arranged between the first processing chamber and the second processing chamber.

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LOCK CHAMBER, INLINE SUBSTRATE PROCESSING SYSTEM AND METHOD OF OPERATING AN INLINE SUBSTRATE PROCESSING SYSTEM

TECHNICAL FIELD

[001] The present disclosure relates to a lock chamber, a processing system and a method of operating a processing system. In particular, the present disclosure relates to a lock chamber for loading/unloading a substrate into/from an inline substrate processing system; an inline substrate processing system including at least a first processing chamber and a second processing chamber for treating a substrate; and a lock chamber for loading/unloading the substrate into/from the inline substrate processing system.

BACKGROUND

[002] In a number of technical applications, multiple layers of the same material or of different materials are deposited on a substrate in a sequence of deposition processes. For instance, in a TFT (Thin Film Transistor) metallization process two or three metals are deposited by a sputtering process. Processes such as etching or structuring may be provided before, between or after the various deposition processes. For example, a multi-layer stack with a sequence of "*material one*", "*material two*" followed again by "*material one*" can be deposited. Such processes may also be employed in the manufacturing of, for example, electrochemical devices such as Thin Film Batteries (TFB). Due to different coating rates, thicknesses of the deposited layers, and etching rates or structuring rates in different processes, the processing time in the processing chambers may vary considerably.

[003] In order to deposit a multi-layer stack, a number of configurations of processing chambers can be provided. For example, inline arrangements of deposition chambers can be used as well as cluster arrangements of deposition chambers. Cluster arrangements may include a central handling chamber and a number of processing chambers or deposition chambers connected thereto.

[004] An inline processing system may include a number of subsequent processing chambers where processes are conducted in one chamber after the other such

that a plurality of substrates can continuously or quasi-continuously be processed. However, when such an inline processing system is undergoing maintenance, e.g. for changing of a sputter target, the entire production line usually has to be stopped. This may result in unexpectedly long down-times and losses in the overall efficiency of the process. Cluster tools, on the other hand, may allow for different cycle times. However, the handling chamber may take up a considerable amount of space and may be very complex. For example, often an elaborate and expensive transfer system may be provided in the handling chamber.

[005] Accordingly, there is an ongoing need for an improved processing system and method of operating a processing system in which the substrate production is maximized and the complexity, cost and footprint of the processing system minimized.

SUMMARY

[006] In view of the above, according to an aspect, an inline substrate processing system for processing an essentially vertically-oriented substrate is provided. The inline substrate processing system includes: a first processing chamber having a first processing region and being adapted to deposit a first material layer on the substrate; a second processing chamber having a second processing region and being adapted to deposit a second material layer on the substrate; and a loadlock chamber adapted to load and unload the substrate from the inline substrate processing system, wherein the loadlock chamber is between the first processing chamber and the second processing chamber.

[007] Further, a loadlock chamber for loading and unloading a substrate into and out of an inline substrate processing system is provided. The loadlock chamber is adapted for being arranged between a first processing chamber and a second processing chamber of the inline substrate processing system such that the substrate may be moved along a first linear transportation path into the first processing chamber and along a second linear transportation path into the second processing chamber.

[008] Furthermore, a method of operating an inline substrate processing system including a first processing chamber, a second processing chamber and a loadlock chamber, wherein the loadlock chamber is between the first processing chamber and the second processing chamber is provided. The method includes: transporting a first substrate from the loadlock chamber into the first processing chamber and depositing a material layer on the first substrate; transporting the first substrate to the second processing chamber via the loadlock chamber and depositing a further material layer on the first substrate or transporting the first substrate to the loadlock chamber and transporting a second substrate into the second processing chamber and depositing a material layer on the second substrate.

[009] Further aspects, advantages and features of the present disclosure are apparent from the dependent claims, the description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Some of the above mentioned embodiments will be described in more detail in the following description of typical embodiments with reference to the following drawings in which:

[0011] Fig. 1 shows a schematic top view of an inline substrate processing system having two processing chambers and a lock chamber according to embodiments described herein;

[0012] Fig. 2 and Fig. 3 show schematic side views of an inline substrate processing system according to embodiments described herein;

[0013] Fig. 4 – Fig. 7 show schematic front views of inline substrate processing systems according to yet further embodiments described herein;

[0014] Fig. 8 shows a schematic top view of an inline substrate processing system including a swing station according to embodiments described herein;

[0015] Fig. 9 shows a schematic top view of an inline substrate processing system having four processing chambers and a lock chamber according to embodiments described herein;

[0016] Fig. 10 shows a schematic top view of an inline substrate processing system according to embodiments described herein; and

[0017] Fig. 11 shows schematically a method of operating an inline substrate processing system according to embodiments described herein.

[0018] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical or similar elements that are common to the figures. It is contemplated that elements and features of one embodiment may be beneficially incorporated in other embodiments described herein. It is also to be noted that the appended drawings illustrate only exemplary embodiments of this disclosure and are therefore not to be considered limiting of its scope.

DETAILED DESCRIPTION

[0019] The wish for less contamination during a vacuum process has increased in the last few years. For instance, when producing displays, the acceptance of contamination with particles has decreased and the standard of quality, and also the quality expected by the customer, has increased. Contamination may for instance occur if the processing chambers of an inline substrate processing system are not properly evacuated to vacuum, if transport systems or components in the inline substrate processing system produce particles during substrate processing procedures, if the substrate to be processed introduces particles into the evacuated inline substrate processing system and the like.

[0020] There is a plurality of possible particle contamination sources in the deposition system during operation, which may influence the product quality. Cleaning and exchanging components as well as continuous vacuum pumping in the inline substrate processing system is a way to reduce the contamination risk of the

product. Nevertheless, it is desirable that the substrate processing procedures are performed in the fastest possible and most efficient way. Cleaning of processing chambers and exchanging procedures take time for maintenance, time which subsequently cannot be used for production time.

[0021] Embodiments described herein relate to an improved inline substrate processing system for high output processing of essentially vertically-oriented substrates. The term "substrate" as used herein shall embrace substrates, such as glass substrates. The substrates are typically large area substrates with a size of 1.4 m^2 and above, typically 5 m^2 and above. For example, substrate sizes of 1.43 m^2 (Gen5) and above, such as 5.5 m^2 (Gen8.5), 9 m^2 (Gen10) or larger can be realized. The term "essentially vertically-oriented" to describe the orientation of the substrate as used herein is to be understood as meaning that the substrate can have some deviation from a vertical orientation, i.e. from a 90° orientation, in the inline substrate processing system in order to allow for stable transport of the substrate with an inclination of the substrate by a few degrees, i.e., the substrates are essentially vertically oriented.

[0022] The inline substrate processing system according to embodiments described herein may process substrates under high vacuum conditions. In order to increase the productivity and to avoid having to evacuate the entire system for each substrate and, especially, the high-vacuum section of the inline substrate processing system, one or more lock chambers may be used for the substrates.

[0023] The task of a lock chamber according to embodiments herein is to load or insert a substrate into the inline substrate processing system and to unload or discharge the substrate out of the inline substrate processing system. The lock chamber may also be referred to as a combined lock-in and lock-out chamber or simply as loadlock chamber hereinafter. Substrates may be transported into the loadlock chamber from a processing chamber or from an arrangement of processing chambers as well as from a load station (e.g. a swing module) for loading substrates to be coated.

[0024] In embodiments herein, the inline substrate processing system may be modular. For instance, the loadlock chamber may be separable from the processing chambers such that the loadlock chamber may be replaced or existing inline

substrate processing systems may be retrofitted with the loadlock chamber according to embodiments described herein.

[0025] The loadlock chamber may be arranged to be evacuated to a sufficient and low enough transition pressure according to the process pressure in the processing chambers as quickly as possible after insertion or loading of a substrate into the inline substrate processing system and to vent as quickly as possible to atmospheric pressure before unloading or discharge of a substrate from the inline substrate processing system. For example, before a substrate is transported into the loadlock from the processing chamber, the loadlock chamber may be evacuated. Before a substrate is transported into the loadlock chamber from the load station for loading substrates, the loadlock chamber may be vented. Similarly, after loading a substrate into the loadlock chamber from the load station, the loadlock chamber may be evacuated.

[0026] According to embodiments herein, the loadlock chamber may include a dual-track configuration or a multi-track configuration providing two or a plurality of positions for substrates received in the loadlock chamber. The loadlock chamber may be adapted to create a pressure differential between the inside of the loadlock chamber and the outside of the loadlock chamber, for instance, by means of a vacuum system such as a vacuum pump. The outside of the loadlock chamber may, for example, be at atmospheric pressure.

[0027] An inline substrate processing system according to embodiments herein may include a three-chamber arrangement including a first processing chamber, a second processing chamber and a loadlock chamber arranged between the first processing chamber and the second processing chamber. However, according to embodiments herein, the inline substrate processing system may include a multi-chamber arrangement having more than three chambers, such as, for example, four chambers, five chambers, six chambers or more chambers. In embodiments including more than four chambers, at least one loadlock chamber may be arranged between a first processing chamber and a second processing chamber. Optionally, further processing chambers may be arranged in line with the first processing chamber and/or the second processing chamber respectively.

[0028] According to embodiments herein, the inline substrate processing system may, for instance, have a five-chamber arrangement including three processing chambers, a first loadlock chamber arranged between the first processing chamber and the second processing chamber, and a second loadlock chamber arranged between the second processing chamber and the third processing chamber.

[0029] According to embodiments herein, in the three-chamber arrangement of the inline substrate processing system, the loadlock chamber may be coupled in line with the first processing chamber and the second processing chamber. For instance, arranging the first processing chamber in line with the loadlock chamber may provide a first substantially linear transportation path that extends from the loadlock chamber to the first processing chamber for transporting a substrate from the loadlock chamber to the first processing chamber. Arranging the second processing chamber in line with the loadlock chamber may provide a second substantially linear transportation path that extends from the loadlock chamber to the second processing chamber for transporting a substrate from the loadlock chamber to the second processing chamber.

[0030] According to embodiments herein, the first substantially linear transportation path and the second substantially linear transportation path may be in line with one another. Such an arrangement of processing chambers and a loadlock chamber may maximize the throughput of the inline substrate processing system. For instance, if one of the processing chambers is shut-down for maintenance, the other processing chamber may be operated normally or if a first process in one of the processing chambers takes more time than a second process in the other processing chamber, more than one substrate may be treated in the other processing chamber by the time the first process is completed. The inline substrate processing system described herein allows for a very efficient and versatile processing of substrates.

[0031] As briefly described above, arranging the loadlock chamber between the first processing chamber and the second processing chamber allows for substrates to be processed sequentially (one after another) in multiple separate processes within the first processing chamber of the inline substrate processing system while during the same period of time one or more substrates may be processed in a longer

single process within the second processing chamber of the inline substrate processing system.

[0032] According to embodiments herein, the loadlock chamber may include a loadlock chamber door adapted to allow the substrates to be loaded into and unloaded from the loadlock chamber in an essentially vertical orientation. The loadlock chamber door may be made of lightweight materials including, for example, aluminium and/or carbon fibres.

[0033] In embodiments described herein, the first processing chamber may include a first processing region adapted to deposit a first material layer on the substrate and the second processing chamber may include a second processing region adapted to deposit a second material layer on the substrate.

[0034] According to embodiments herein, the first material layer and the second material layer deposited on the substrate in the first processing chamber and the second processing chamber respectively may include different materials. For example, the first material layer may include molybdenum and the second material layer may include aluminium. In yet further embodiments herein, the first material layer and the second material layer deposited on the substrate in the first processing chamber and the second processing chamber respectively may include the same material.

[0035] According to embodiments herein, in order to deposit a layer stack on the substrate, the substrate may cycle between the first processing chamber and the second processing chamber. For instance, the substrate may be coated with a material layer from the first processing chamber, with a further material layer from the second processing chamber and with a yet further material layer from the first processing chamber. The deposition parameters may be kept constant or changed during the separate coating processes.

[0036] According to embodiments herein, which can be combined with other embodiments herein, the deposition sources may be provided as sputtering targets, such as rotatable sputtering targets. According to implementations of the inline substrate processing system, a DC sputtering, a pulse sputtering, or a middle frequency (MF)

sputtering can be provided. According to yet further embodiments described herein, the MF sputtering can, for instance, be provided with frequencies in the range from 5 kHz to 100 kHz, for example, from 30 kHz to 50 kHz.

[0037] Fig. 1 shows a schematic top view of an inline substrate processing system 100 having two processing chambers 110, 120 and a loadlock chamber 130 according to embodiments described herein. The first processing chamber 110 may include one or more sputtering targets 111 for depositing material on a substrate in a first processing region 116. The second processing chamber 120 may include one or more sputtering targets 121 for depositing material on the same substrate or a different substrate in a second processing region 126. Isolation valves, such as vacuum valves 119, 129 are arranged between the loadlock chamber 130 and the first processing chamber 110 and between the loadlock chamber 130 and the second processing chamber 120 respectively.

[0038] The isolation valves may be positioned in line with the loadlock chamber and the processing chambers, and can transition from a closed to an open state and vice versa to pass a substrate moving in the direction indicated by arrow 138. The vacuum valve 119 may be controlled to allow a substrate to move from the loadlock chamber 130 into and out of the first processing chamber 110. Vacuum valve 129 may also be controlled to allow a substrate to move from loadlock chamber 130 into and out of the second processing chamber 120.

[0039] According to embodiments described herein, the inline substrate processing system may be adapted to have more than two processing chambers. For example, the inline substrate processing system may include further processing chambers arranged on either side of the first processing chamber and the second processing chamber respectively.

[0040] As briefly mentioned above, according to embodiments herein, the loadlock chamber may function to provide a transition from atmospheric conditions to low pressure conditions such as, for instance, from atmospheric pressure to anywhere from 10^{-3} mbar to 10^{-7} mbar, for example, from 10^{-3} mbar to 10^{-6} mbar or from 10^{-3} mbar to 10^{-4} mbar. According to embodiments herein, the loadlock chamber may be

adapted to transfer a substrate to the processing chamber without essentially disturbing the vacuum conditions in the processing chamber. The loadlock chamber according to embodiments described herein may be evacuable to vacuum, and may include respective equipment, such as one or more vacuum pumps 135.

[0041] According to embodiments described herein, the loadlock chamber may have one or more substrate loading/unloading openings for receiving a substrate, optionally supported by a substrate carrier, being delivered in atmospheric conditions or for discharging a substrate, optionally supported by a substrate carrier, to atmospheric conditions. The term substrate as used hereinafter may refer to both a substrate and/or to a substrate supported by a substrate carrier.

[0042] According to embodiments herein, the loading/unloading opening 133 may be closed and opened by a loadlock chamber door 134. In embodiments described herein, opening the loadlock chamber door 134 provides access to the inside of the loadlock chamber 130. According to embodiments herein, the loadlock chamber door 134 may be arranged on a lateral side of the loadlock chamber 130.

[0043] The loadlock chamber may have one or more substrate transfer openings adapted for being connected to one or more vacuum chambers, such as one or more processing chambers. According to embodiments herein, the loadlock chamber 130 may have a first substrate transfer opening 137 and a second substrate transfer opening 139 adapted for being connected to the first processing chamber 110 and the second processing chamber 120, respectively.

[0044] According to the embodiments herein, a substrate may be transported through the inline substrate processing system either without a carrier or attached to a carrier in order to be processed. The inline substrate processing system 100 shown in Fig. 1 includes a substrate 131 attached to a substrate carrier 132. In the embodiments described herein, a linear transportation path may be understood as an in-line path on which the substrate, the substrate carrier (particularly a substrate carrier having a substrate attached thereto) may be transported without a need to rotate the substrate/carrier in order to change the lateral position of the substrate/carrier or to

displace the substrate/carrier laterally. On the other hand, the linear path may include deviations of the direction of the transportation path from a straight line.

[0045] The inline substrate processing system 100 shows a first substantially linear transportation path 114 for transporting the substrate 131 attached to the substrate carrier 132 to the first processing chamber 110. The inline substrate processing system 100 includes a second substantially linear transportation path 124 for transporting the substrate 131 attached to the substrate carrier 132 to the second processing chamber 120.

[0046] The first transportation path and the second transportation path may be arranged in line with the loadlock chamber and the processing chambers. For example, the first linear transportation path 114 may extend from the inside of the loadlock chamber 130 into the first processing chamber 110. According to embodiments herein, the first transportation path 114 may extend from the inside of the loadlock chamber 130 through the first substrate transfer opening 137 into the first processing chamber 110. The second linear transportation path 124 may extend from the inside of the loadlock chamber 130 into the second processing chamber 120. According to embodiments herein, the second transportation path 124 may extend from the inside of the loadlock chamber 130 through the second substrate transfer opening 139 into the second processing chamber 120.

[0047] According to embodiments herein, the loading/unloading opening 133 and the loadlock chamber door 134 may be adapted to allow the substrate 131, optionally including the substrate carrier 132, to be loaded into and unloaded from the loadlock chamber of the inline substrate processing system in a direction essentially perpendicular to the substantially linear transportation path of the substrate within the inline substrate processing system. For example, the substrate may be loaded into and/or unloaded from the loadlock chamber in a direction essentially perpendicular to at least one of the first linear transportation path 114 and the second linear transportation path 124.

[0048] According to embodiments described herein, the loadlock chamber door may be adapted for the option of loading a substrate together with a

substrate carrier into the inline substrate processing system and for the option of unloading a substrate together with a substrate carrier from the inline substrate processing system. For example, according to embodiments herein, the loadlock chamber door may include a transportation system, such as a carrier transportation drive. The carrier transportation drive may be adapted to load the substrate optionally supported by the substrate carrier onto the loadlock chamber door and to unload the substrate optionally supported by the substrate carrier from the loadlock chamber door. According to embodiments herein, providing a loadlock chamber door with a carrier transportation drive facilitates an efficient and simple loading/unloading of substrates into/from the inline substrate processing system.

[0049] In embodiments described herein, the substrate, optionally including the substrate carrier may be loaded into and/or unloaded from the loadlock chamber of the inline substrate processing system by being tilted at an angle. For example, for loading a substrate into the loadlock chamber the substrate may be displaced from a horizontal position into a vertical position. According to embodiments herein, the substrate, optionally including a substrate carrier, may, for instance, be in the horizontal position at an angle of essentially 0° and may be raised into the vertical position at an angle of essentially 90° in order to be loaded into the loadlock chamber. The substrate, optionally including the substrate carrier, may, for instance, be unloaded from the loadlock chamber in a reverse manner to the substrate, optionally including the substrate carrier being loaded into the loadlock chamber.

[0050] According to embodiments herein, the substrate 131, optionally including the substrate carrier 132, once loaded into the loadlock chamber may be transported between the first linear transportation path 114 and the second linear transportation path 124 by a lateral movement device. In embodiments described herein, the surface of the substrate, which is to be processed, may be adjusted to the same side of the inline substrate processing system. The substrate processing tools, such as, for example, the sputter target(s) may be arranged on the same side relative to the first transportation path and the second transportation path. According to embodiments herein, the substrate processing tools may, for instance, be arranged in the respective processing chamber laterally beside the transportation path.

[0051] In embodiments described herein, the first processing chamber and the second processing chamber may include a vacuum device. For example, the first processing chamber 110 may include a vacuum pump 112 and the second processing chamber 120 may include a vacuum pump 122 for evacuating each of the processing chambers. In yet further embodiments herein, each of the processing chambers of the inline substrate processing system may include more than one vacuum pump respectively.

[0052] In embodiments herein, the inline substrate processing system may include a transport system for transporting a substrate along the first transportation path and along the second transportation path. For example, the inline substrate processing system may include an eccentric substrate handling drive. During transport along the transportation path, the substrate may be supported in a substrate carrier. The substrate may be attached to the substrate carrier. In yet further embodiments herein, the substrate may pass through the inline substrate processing system without a carrier. According to embodiments herein, the transport system may be configured to transport the substrate and/or the substrate carrier along the transportation paths, at least between the loadlock chamber, the first processing chamber and the second processing chamber.

[0053] According to embodiments herein, the transport system may include means for guiding the substrate along the first transportation path and/or along the second transportation path. The means for guiding the substrate may include one or more rails (usually arranged at the bottom and/or at the top of the loadlock chamber and the processing chamber(s); provided that substrates are aligned vertically or at least inclined during the transport through the inline substrate processing system). The means for guiding the substrate may include a magnetic guiding system which may be arranged at the top of the essentially vertically aligned substrate. However, any other transport system may be used in connection with the present disclosure.

[0054] Fig. 2 shows a schematic side view of an inline substrate processing system 200 according to embodiments herein. All the features described with respect to Fig. 1 also apply to the embodiment shown in Fig. 2. For example, as described with respect to Fig. 1 above, the inline substrate processing system 200 includes a first processing chamber 110, a second processing chamber 120 and a

loadlock chamber 130 arranged between the first processing chamber 110 and the second processing chamber 120. Isolation valves may be arranged between the loadlock chamber 130, the first processing chamber 110 and the second processing chamber 120 respectively. In the embodiment shown in Fig. 2 only the vacuum valve 129 between the loadlock chamber 130 and the second processing chamber 120 is shown. The loadlock chamber 130 including the loadlock chamber door 234 of Fig. 2 may be used in combination with any of the other embodiments described herein.

[0055] According to embodiments herein, the loadlock chamber door 234 may be configured to move sidewardly with the carrier (see Fig. 1). Arrow 238 indicates the sideward movement direction of the loadlock chamber door 234. According to embodiments herein, the loadlock chamber door 234 may be moveable in a direction parallel to at least one of the first linear transportation path 114 and the second linear transportation path 124 (see Fig. 1). The loadlock chamber door 234 of the loadlock chamber 130 may be configured to slide across a lateral side of the first processing chamber 110 in order to provide the loading/unloading opening 133 for a substrate to be loaded into and/or unloaded from the loadlock chamber 130. Similarly, according to embodiments herein, the loadlock chamber door 234 may be adapted to slide across a lateral side of the second processing chamber 120 in order to provide the loading/unloading opening 133 for a substrate to be loaded into and/or unloaded from the loadlock chamber 130.

[0056] According to embodiments herein, a loadlock chamber door support system 250 may allow the loadlock chamber door 234 to easily slide across the lateral side of the first processing chamber 110 and/or across the lateral side of the second processing chamber 120. In embodiments described herein, a loadlock chamber door that can be opened and closed for loading/unloading a substrate into/from the loadlock chamber by sliding across the first processing chamber or the second processing chamber provides the advantage that the loadlock chamber door support system may have a very small foot print.

[0057] In embodiments described herein, the loadlock chamber door support system 250 may, for instance, include one or more guide rails. The one or more guide rails may be arranged on the outside of the first processing chamber and/or the

second processing chamber respectively. According to embodiments herein, the first processing chamber may include two guide rails. The first guide rail may be arranged in an upper region of the first processing chamber such as, for instance, along an upper edge of the first processing chamber.

[0058] The second guide rail may be arranged in a lower region of the first processing chamber such as, for instance, along a lower edge of the first processing chamber. Similarly, the second processing chamber may include two guide rails. The first guide rail may be arranged in an upper region of the second processing chamber such as, for instance, along an upper edge of the second processing chamber. The second guide rail may be arranged in a lower region of the second processing chamber such as, for instance, along a lower edge of the second processing chamber.

[0059] Fig. 3 shows an inline substrate processing system 300 according to embodiments herein. All the features described with respect to Fig. 1 also apply to the embodiment shown in Fig. 3. For example, the inline substrate processing system 300 includes a first processing chamber 110, a second processing chamber 120 and a loadlock chamber 130 arranged between the first processing chamber 110 and the second processing chamber 120. Vacuum valves 119, 129 may be arranged between the loadlock chamber 130, the first processing chamber 110 and the second processing chamber 120 respectively. The loadlock chamber 130 including the loadlock chamber door 334 of Fig. 3 may be used in combination with any of the other embodiments described herein.

[0060] According to embodiments herein, the loadlock chamber door 334 may be adapted to be moveable in a direction perpendicular to at least one of the first linear transportation path 114 and the second linear transportation path 124 (see Fig. 1). In embodiments described herein, the loadlock chamber door 334 may be adapted to be moveable in a direction parallel to the vertical axis 339 of the loadlock chamber 130 of the inline substrate processing system 300. Arrow 338 in Fig. 3 indicates the upward and downward movement direction of loadlock chamber door 334.

[0061] According to embodiments herein, a loadlock chamber door support system 350 may allow the loadlock chamber door 334 to easily move upward

and downward in order to open and close the loading/unloading opening 133 of the loadlock chamber 130. For example, the loadlock chamber door support system 350 may include one or more rails. The loadlock chamber door support system 350 may include a hydraulic, a pneumatic and/or spring-based mechanism for assisting the movement of the loadlock chamber door 334.

[0062] Fig. 4 through Fig. 7 show schematic front views of inline substrate processing systems according to yet further embodiments described herein. All the features described with respect to Fig. 1 also apply to the embodiments shown in Figs. 4 through 7. The inline substrate processing system 400 of Fig. 4 shows the loadlock chamber 130 including a loadlock chamber door 434 that is adapted to be tilted away from and towards the loadlock chamber 130 of the inline substrate processing system 400. Arrow 438 shows the movement of the loadlock chamber door according to embodiments herein. For instance, the loadlock chamber door 434 may be opened to provide access to the inside of the loadlock chamber 130 by being moved away from the vertical axis 339 of the loadlock chamber 130.

[0063] The loadlock chamber door 434 may be closed by being moved towards the vertical axis 339 of the loadlock chamber 130. According to embodiments herein, the loadlock chamber door 434 may be opened by being moved outwards and upwards with respect to the loadlock chamber 130, and closed by being moved downwards and inwards towards the loadlock chamber 130.

[0064] In embodiments described herein, the loadlock chamber door 434 may be attached to the loadlock chamber 130 by a loadlock chamber door support system 450. For example, the loadlock chamber door support system 450 may include one or more hinges and/or any one or more of the elements chosen from the following list: a hydraulic, a pneumatic and a spring-based mechanism for assisting the movement of the loadlock chamber door 434.

[0065] According to embodiments herein, the loadlock chamber door support system may allow the loadlock chamber door to have a range of motion from 0° to 180° with respect to the loadlock chamber. For example, the loadlock chamber door may be considered as closed in a position of essentially 0° with respect to the loadlock

chamber and the loadlock chamber door may be considered as opened in a position of essentially 90° with respect to the loadlock chamber.

[0066] According to the embodiment shown in Fig. 4, the loadlock chamber door 434 being opened by being moved outwards and upwards with respect to the loadlock chamber 130, and closed by being moved downwards and inwards towards the loadlock chamber 130 may provide a lot of space for easily loading/unloading substrates into and out of the loading chamber of the inline substrate processing system.

[0067] Fig. 5 shows a further inline substrate processing system 500 according to embodiments described herein. The loadlock chamber door 534 may be adapted to be tilted away from and towards the loadlock chamber of the inline substrate processing system 500. Arrow 538 shows the movement direction of the loadlock chamber door according to embodiments herein. Similar to the embodiment described with respect to the Fig. 4 above, the loadlock chamber door 534 may be opened to provide access to the inside of the loadlock chamber 130 by being moved away from the vertical axis 339 of the loadlock chamber 130. The loadlock chamber door 534 may be closed by being moved towards the vertical axis 339 of the loadlock chamber 130.

[0068] According to the embodiment shown in Fig. 5, the loadlock chamber door 534 may be opened by being moved outwards and downwards with respect to the loadlock chamber 130, and closed by being moved upwards and inwards towards the loadlock chamber 130. Not limited to the embodiment shown in Fig. 5, the loadlock chamber door may be considered to be closed when being in an essentially vertical orientation and the loadlock chamber door may be considered to be fully opened when being in an essentially horizontal orientation.

[0069] According to embodiments described herein, the loadlock chamber door 534 may be attached to the loadlock chamber 130 by a loadlock chamber door support system 550. For example, the loadlock chamber door support system 550 may include one or more hinges and/or any one or more of the elements chosen from the following list: a hydraulic, a pneumatic or a spring-based mechanism for assisting the movement of the loadlock chamber door 534. According to embodiments herein, the loadlock chamber door support system may allow the loadlock chamber door to have a

range of motion from 0° to 180° with respect to the loadlock chamber. For example, the loadlock chamber door may be considered as closed in a position of essentially 0° with respect to the loadlock chamber and the loadlock chamber door may be considered as opened in a position of essentially 90° with respect to the loadlock chamber.

[0070] According to the embodiment shown in Fig. 5, the loadlock chamber door 534 being opened by being moved outwards and downwards with respect to the loadlock chamber 130 may be more easily and rapidly opened by taking advantage of the influence of gravity acting on the loadlock chamber door 534.

[0071] Fig. 6 shows a further inline substrate processing system 600 according to embodiments described herein. The embodiment of Fig. 6 may resemble the inline substrate processing system of Fig. 5 with the exception that the loadlock chamber door support system 650 of the inline substrate processing system 600 may be adapted to load/unload a substrate 131, optionally supported by a substrate carrier 132, into or from the loadlock chamber 130 together with the loadlock chamber door 634.

[0072] The movement direction of the loadlock chamber door 634 together with the substrate 131, optionally supported by a substrate carrier 132, between a loading and unloading position is shown with arrow 638. According to embodiments herein, the loadlock chamber door of the embodiment shown in Fig. 6 may have the same range of motion as the loadlock chamber door described with respect to the embodiment shown in Fig. 5.

[0073] Fig. 7 shows a further inline substrate processing system 700 according to embodiments described herein. The loadlock chamber door 734 may be adapted to be moveable in a direction essentially perpendicular to at least one of the first linear transportation path 114 and the second linear transportation path 124 (see Fig. 1). Arrow 738 shows the movement direction of the loadlock chamber door according to embodiments herein.

[0074] The loadlock chamber 130 may be configured to be opened by moving the loadlock chamber door 734 away from the loadlock chamber 130 and closed by moving the loadlock chamber door 734 towards the loadlock chamber 130.

According to the embodiment shown in Fig. 7, the loadlock chamber door 734 may be opened by being moved in an essentially vertical orientation along an essentially horizontal path away from the loadlock chamber 130. Similarly, for closing the loadlock chamber 130, for instance, after having loaded/unloaded a substrate into the loadlock chamber 130, the loadlock chamber door 734 may be moved in an essentially vertical orientation along the essentially horizontal path towards the loadlock chamber 130.

[0075] In embodiments described herein, the loadlock chamber door may be adapted to load a substrate, optionally together with a substrate carrier, into the inline substrate processing system and to unload a substrate, optionally together with a substrate carrier, from the inline substrate processing system. For instance, the loadlock chamber door may include a transportation drive, such as a carrier transportation drive.

[0076] The carrier transportation drive may be adapted to load the substrate optionally connected to the substrate carrier onto the loadlock chamber door and to unload the substrate optionally connected to the substrate carrier from the loadlock chamber door. According to embodiments herein, providing a loadlock chamber door with a carrier transportation drive facilitates an efficient and simple loading/unloading of substrates into/from the inline substrate processing system.

[0077] According to embodiments described herein, the loadlock chamber door 734 may be supported by a loadlock chamber door support system 750. For example, the loadlock chamber door support system 750 may include one or more rails, such as guiding rails. For example, one or more rails 751 may be arranged in a top region of the loadlock chamber 130 and extend essentially outward, away from the loadlock chamber 130. The loadlock chamber door 734 may be adapted to move along the one or more rails 751.

[0078] According to further embodiments herein, the loadlock chamber support system 750 may include one or more rails 752 arranged in a bottom region of the loadlock chamber 130. The one or more rails may extend essentially outward, away from the loadlock chamber 130. The loadlock chamber door 734 may be adapted to move along the one or more rails 752.

[0079] In yet further embodiments described herein, the loadlock chamber support system 750 may include both, one or more rails 751 arranged in a top region of the loadlock chamber 130 and one or more rails 752 arranged in a bottom region of the loadlock chamber 130. Having one or more rails arranged in a top region and in a bottom region of the loadlock chamber 130 may increase the movement precision of the loadlock chamber door.

[0080] Fig. 8 shows a further inline substrate processing system 800 according to embodiments described herein. All the features described with respect to Fig. 1 also apply to the embodiment shown in Fig. 8. According to embodiments described herein, the inline substrate processing system includes a swing station that is adapted to support a substrate, optionally supported on a substrate carrier, and transfer the substrate, optionally including the substrate carrier from an essentially horizontal position to an essentially vertical position.

[0081] For example, the inline substrate processing system 800 shown in Fig. 8 includes a swing station, such as, for instance, a swing module 860. The substrate 131 and substrate carrier 132, as well as the loadlock chamber door 834 are shown in a horizontal position supported by the swing module 860. According to embodiments herein, the swing module 860 may bring the substrate 131, the substrate carrier 132 and the loadlock chamber door 834 into an essentially vertical position in order to load the substrate 131 together with the substrate carrier 132 into the loadlock chamber 130.

[0082] The loadlock chamber door 834 may be in position to close the loadlock chamber 130 together with the loading of the substrate 131 and the substrate carrier 132 into the loadlock chamber 130. From within the loadlock chamber, the substrate 131 and the substrate carrier 132 may be transferred into the first processing chamber 110 and/or the second processing chamber 120 of the inline substrate processing system respectively. Utilizing the swing station for moving the substrate, optionally supported by a substrate carrier, together with the loadlock chamber door may reduce the complexity and the total cost of ownership of the inline substrate processing system.

[0083] Fig. 9 shows a schematic top view of an inline substrate processing system 900 having four processing chambers 910, 920, 940, 950 and a loadlock chamber 930 according to embodiments described herein. The first processing chamber 910 may include one or more sputtering targets 911 for depositing material on a substrate in a first processing region 916. The second processing chamber 920 may include one or more sputtering targets 921 for depositing material on the same substrate or a different substrate in a second processing region 926. The third processing chamber 940 may include one or more sputtering targets 941 for depositing material on a substrate in a third processing region 946. The fourth processing chamber 950 may include one or more sputtering targets 951 for depositing material on a substrate in a fourth processing region 956.

[0084] According to embodiments herein, the loadlock chamber 930 may be arranged between the first processing chamber 910 and the second processing chamber 920 as well as between the third processing chamber 940 and the fourth processing chamber 950.

[0085] One or more isolation valves, such as vacuum valves 919, 929, 943, 953, may be arranged between the loadlock chamber 930 and the processing chambers 910, 920, 940, 950. The vacuum valves may be positioned in line with the loadlock chamber 930 and each of the respective processing chambers 910, 920, 940, 950, and can transition from a closed to an open state and vice versa to pass a substrate moving in the direction indicated by arrow 938. The vacuum valves 919, 929, 953, 943 may be controlled to allow a substrate to move from the loadlock chamber 930 into and out of the respective processing chambers 910, 920, 940, 950.

[0086] Similarly to the loadlock chamber described with respect to Fig. 1, the loadlock chamber 930 of the embodiment shown in Fig. 9 may be adapted to provide a transition from atmospheric conditions to low pressure conditions. The loadlock chamber according to embodiments described herein may be evacuable to vacuum, and may include respective equipment, such as one or more vacuum pumps 935.

[0087] According to embodiments herein, the inline substrate processing system 900 shown in Fig. 9 may include one or more substrate loading/unloading openings 933. For example, the loadlock chamber may include a substrate loading/unloading opening on each side of the loadlock chamber and a loadlock chamber door on each side of the loadlock chamber. In embodiments herein, the loadlock chamber 930 may include a loadlock chamber door 934. The loadlock chamber door 934 may be opened and closed to allow a vacuum to be formed within the loadlock chamber 930.

[0088] According to embodiments herein, the loadlock chamber door 934 may be arranged on a lateral side of the inline substrate processing system 900. Any one of the loadlock chamber door variants shown in the embodiments depicted in Fig. 2 to Fig. 8 or any combination of these loadlock chamber door variants may be applied to the inline substrate processing system 900 of Fig. 9.

[0089] The loadlock chamber may have one or more substrate transfer openings adapted for being connected to one or more vacuum chambers, such as one or more processing chambers. According to embodiments herein, the loadlock chamber 930 may have a first substrate transfer opening 937, a second substrate transfer opening 939, a third substrate transfer opening 949 and a fourth substrate transfer opening 957 each adapted for being connected to a respective processing chamber. In embodiments described herein, the substrate transfer openings are adapted to transfer an essentially vertically-oriented substrate and can have the shape of a slit. The slit may be opened and closed by means of a vacuum valve.

[0090] According to the embodiments herein, a substrate may be transported through the inline substrate processing system either without a carrier or attached to a carrier in order to be processed. Similarly to the embodiment shown in Fig. 1 and described in more detail above, the inline substrate processing system 900 shown in Fig. 9 includes a substrate 931 attached to a substrate carrier 932.

[0091] The inline substrate processing system 900 shows four substantially linear transportation paths. The first substantially linear transportation path 914 is arranged between the loadlock chamber 930 and the first processing

chamber 910 for transporting the substrate 931 attached to the substrate carrier 932 to the first processing chamber 910. The second substantially linear transportation path 924 is arranged between the loadlock chamber and the second processing chamber 920 for transporting the substrate 931 attached to the substrate carrier 932 to the second processing chamber 920. The third substantially linear transportation path 944 is arranged between the loadlock chamber 930 and the third processing chamber 940 for transporting the substrate 931 attached to the substrate carrier 932 to the third processing chamber 910. The fourth substantially linear transportation path 954 is arranged between the loadlock chamber 930 and the fourth processing chamber 950 for transporting the substrate 931 attached to the substrate carrier 932 to the fourth processing chamber 950. Each of the substantially linear transportation paths may extend from the inside of the loadlock chamber through a respective transfer opening and into a respective processing chamber.

[0092] Similarly to the embodiment shown in Fig. 1, the loading/unloading opening 933 and the loadlock chamber door 934 of the embodiment shown in Fig. 9 may be adapted to allow the substrate 931, optionally including the substrate carrier 932, to be loaded into and unloaded from the loadlock chamber of the inline substrate processing system in a direction essentially perpendicular to at least one of the substantially linear transportation paths of the substrate within the inline substrate processing system. For example, the substrate may be loaded into and/or unloaded from the loadlock chamber in a direction essentially perpendicular to at least one of the first linear transportation path 914, the second linear transportation path 924, the third linear transportation path 944 and the fourth linear transportation path 954.

[0093] According to embodiments herein, the substrate 931, optionally including the substrate carrier 932 once loaded into the loadlock chamber 930 may be transported between the first linear transportation path 914 and the second linear transportation path 924 by means of a lateral movement, and between the third linear transportation path 944 and the fourth linear transportation path 954 by means of a lateral movement. In embodiments described herein, the substrate 931, optionally including the substrate carrier 932 may be moved laterally along the linear transportation paths by a first transportation system. The first transport system may, for

instance, include an eccentric transportation drive such as an eccentric carrier transportation drive.

[0094] In embodiments described herein, the loadlock chamber 930 may include a second transportation system. For example, the second transportation system may include a transfer system 970 adapted to transfer a substrate 931, optionally including a substrate carrier 932 between the first linear transportation path 914 and the third linear transportation path 944 and/or between the first linear transportation path 114 and the fourth linear transportation path 954, and vice versa. According to embodiments herein, the transfer system may be adapted to move the substrate in a direction essentially perpendicular to any one of the linear transportation paths. For example, the transfer system 970 may transfer the substrate 931, optionally supported by the substrate carrier 932 from the first linear transportation path 914 to the third linear transportation path 944. The transfer direction is indicated in Fig. 9 by arrow 971.

[0095] Fig 10 shows schematically a top view of an inline substrate processing system 1000 having two processing chambers 1010, 1020 and a loadlock chamber 1030 according to embodiments herein. Similar to the inline substrate processing system shown in Fig. 1, the first processing chamber 1010 may include one or more sputtering targets 1011 for depositing material on a substrate in a first processing region 1016. The second processing chamber 1020 may include one or more sputtering targets 1021 for depositing material on the same substrate or a different substrate in a second processing region 1026. According to embodiments herein, the loadlock chamber 1030 is arranged between the first processing chamber 1010 and the second processing chamber 1020.

[0096] Similar to the inline substrate processing system shown in Fig. 1, the inline substrate processing system 1000 may include one or more isolation valves arranged between the loadlock chamber and the processing chambers; one or more substrate transfer openings arranged between the loadlock chamber and each of the processing chambers; and one or more vacuum pumps arranged to evacuate the loadlock chamber and the processing chambers. The inline substrate processing system 1000 includes two linear transportation paths. The first linear transportation path 1014 is arranged between the loadlock chamber 1030 and the first processing chamber 1010 for

transporting a substrate attached to a substrate carrier to the first processing chamber 1010. The second linear transportation path 1024 is arranged between the loadlock chamber 1030 and the second processing chamber 1020 for transporting a substrate attached to a substrate carrier to the second processing chamber 1020.

[0097] According to the embodiment shown in Fig. 10, a first substrate 1031 supported by a substrate carrier 1032 may be transferred from the loadlock chamber 1030 along the first linear transportation path 1014 to be processed in processing region 1016 of the first processing chamber 1010. The movement direction to transfer the substrate 1031 supported by the substrate carrier 1032 from the loadlock chamber 1030 to and from the first processing chamber 1010 is indicated by arrow 1038 and may be described as being essentially parallel to at least one of the first linear transportation path 1014 and the second linear transportation path 1024.

[0098] The loadlock chamber door 1034 may be opened in that the loadlock chamber door 1034 is moved away from the loadlock chamber 1030 indicated by arrow 1071. The loadlock chamber door 1034 may include a transportation system such as, for instance, a carrier transportation drive 1070 for loading a new substrate 1041 supported by a substrate carrier 1042 onto the loadlock chamber door 1034 and for unloading a processed substrate 1052 supported by a substrate carrier 1051 from the loadlock chamber door 1034.

[0099] The movement direction to load the substrate 1041 supported by the substrate carrier 1042 on to the loadlock chamber door 1034 is indicated by arrow 1091 and may be described as being essentially parallel to at least one of the first linear transportation path 1014 and the second linear transportation path 1024. The movement direction to unload the substrate 1051 supported by the substrate carrier 1052 from the loadlock chamber door 1034 is indicated by arrow 1081 and may be described as being essentially parallel to at least one of the first linear transportation path 1014 and the second linear transportation path 1024. According to embodiments herein, the movement direction of the substrates may also be in an opposite direction to the directions indicated in the embodiment shown in Fig. 10.

[00100] According to embodiments herein, the loadlock chamber door 1034 may be closed and opened together with a substrate supported by a substrate carrier. The movement direction of the loadlock chamber door 1034 being closed and opened is indicated with arrow 1071 and may be described as moving towards and away from the loadlock chamber 1030. According to embodiments herein, the loadlock chamber door 1034 is adapted to be moveable in a direction perpendicular to at least one of the first linear transportation path 1016 and the second linear transportation path 1026 together with a substrate carrier. For instance, in the embodiment shown in Fig. 10, the loadlock chamber door 1034 may be moved together with the substrate 1041 supported by the substrate carrier 1042 towards the opening 1033 of the loadlock chamber 1030 in order to close the loadlock chamber 1030.

[00101] The loadlock chamber 1030 may be evacuated and the substrate 1041 supported by the substrate carrier 1042 may be transferred to, for instance, the second processing region 1026 of the second processing chamber 1020 along the second transportation path 1024.The loadlock chamber door 1034 described with respect to the embodiment shown in Fig. 10 may be combined with any of the other embodiments described herein, such as, for instance, the inline substrate processing chamber 900, shown in Fig. 9.

[00102] Fig. 11 shows schematically a method 1100 of operating an inline substrate processing system according to embodiments described herein. The inline substrate processing system including a first processing chamber, a second processing chamber and a loadlock chamber, wherein the loadlock chamber is between the first processing chamber and the second processing chamber. The method including transporting a first substrate from the loadlock chamber into the first processing chamber and depositing a material layer on the first substrate 1110, and transporting the first substrate to the second processing chamber via the loadlock chamber and depositing a further material layer on the first substrate 1120 or transporting the first substrate to the loadlock chamber and transporting a second substrate into the second processing chamber and depositing a material layer on the second substrate 1130.

[00103] According to embodiments herein, the method may further include performing a maintenance process in the first processing chamber 1140. The

maintenance process may for instance include exchanging one or more sputter targets and/or decontaminating the first processing chamber.

[00104] According to embodiments herein, the method may further include loading the first substrate and/or the second substrate into the inline substrate processing system in a direction essentially perpendicular to the transport direction of the first substrate 1150. The transport direction of the first substrate being the linear path of the first substrate being transported from the loadlock chamber to the first processing chamber.

[00105] In embodiments described herein, a method of operating an inline substrate processing system as shown in Fig. 1, for instance, may include loading a first substrate and a first substrate carrier in an essentially vertical orientation into the loadlock chamber 130. Closing the loadlock chamber door 134 and evacuating the loadlock chamber 130 by means of the vacuum pump 135. The loadlock chamber 130 may be evacuated to a transition pressure according to the process range in one of the processing chambers, for instance, with respect to the process range in the first processing chamber 110. The first substrate and the first substrate carrier may be transported along the first transportation path 114 from the loadlock chamber into the first processing chamber 110, where first material layer is deposited on the surface of the first substrate.

[00106] The first substrate may subsequently be transported back into the loadlock chamber 130 and into the second processing chamber 120. In the second processing chamber 120, a further material layer may be deposited on top of the first material layer. When the first substrate is transported from the loadlock chamber 130 to the first processing chamber 110, back to the loadlock chamber 130 and into the second processing chamber 120, the first substrate may travel along the first linear transportation path 114 and along the second linear transportation path 124. According to embodiments herein the first linear transportation path 114 and the second linear transportation path 124 may be in line with each other and form a single linear transportation path extending from the first processing chamber 110 through the loadlock chamber 130 and into the second processing chamber 120. The loadlock chamber 130 may be vented and the loadlock chamber door 134 opened.

[00107] A second substrate and a second substrate carrier may be loaded into the loadlock chamber 130 in an essentially vertical orientation. Once the second substrate and the second carrier are loaded into the loadlock chamber 130, the loadlock chamber door 134 may be closed and the loadlock chamber 130 evacuated. The loadlock chamber 130 may be evacuated to a transition pressure according to the process range in the first processing chamber 110. The second substrate and the second substrate carrier may be transported along the first transportation path 114 from the loadlock chamber into the first processing chamber 110, where a first material layer is deposited on the surface of the second substrate. While the first substrate and the first substrate carrier are still in the second processing chamber 120, the second substrate and the second substrate carrier may be transported from the first processing chamber 110 to the loadlock chamber 130.

[00108] Subsequently, the loadlock chamber 130 may be vented and the second substrate and the second substrate carrier unloaded from the loadlock chamber 130. For instance, a third substrate and a third substrate carrier may be loaded into the loadlock chamber 130 in an essentially vertical orientation and transported into the first processing chamber 110 as described with respect to the second substrate and second carrier above. A first material layer may be deposited on the surface of the third substrate. In the meantime, the first substrate and the first substrate carrier may be transported from the second processing chamber 120 to the loadlock chamber 130 and unloaded from the loadlock chamber 130 and a fourth substrate and a fourth substrate carrier may be loaded into the loadlock chamber and transported into the second processing chamber 120. A first material layer may be deposited on the surface of the fourth substrate in the second processing chamber 120.

[00109] A plurality of substrates, optionally supported on substrate carriers may cycle through the first chamber and the second chamber of the inline substrate processing system as described herein. The movement of the substrates from the loadlock chamber into the first processing chamber and/or the second processing chamber may be synchronized to optimize the occupancy of the first processing chamber independently from the occupancy of the second processing chamber. The inline substrate processing system according to embodiments herein may avoid any

bottlenecks that may occur in conventional inline substrate processing systems with a plurality of processing chambers arranged one after the other.

[00110] Although specific features of various embodiments of the disclosure may be shown in some drawings and not in others, this is for convenience only. Any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.

[00111] 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, those skilled in the art will recognize that the intention of the claims allows for equally effective modifications. Especially, mutually non-exclusive features of the embodiments described above may be combined with each other. The patentable scope is defined by the claims, and may include such modifications and other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

CLAIMS

1. An inline substrate processing system (100) for processing an essentially vertically-oriented substrate (131), comprising:

a first processing chamber (110) having a first processing region (116) and being adapted to deposit a first material layer on the substrate;

a second processing chamber (120) having a second processing region (126) and being adapted to deposit a second material layer on the substrate; and

a loadlock chamber (130) adapted to load and unload the substrate from the inline substrate processing system,

wherein the loadlock chamber is between the first processing chamber and the second processing chamber.

2. The inline substrate processing system (100) of claim 1, wherein the loadlock chamber is adapted to transport the substrate into the first processing region along a first linear transportation path (114) and into the second processing region along a second linear transportation path (124).

3. The inline substrate processing system (100) of claim 2, wherein the loadlock chamber is adapted to allow the substrate to be loaded into and unloaded from the inline substrate processing system in a direction perpendicular to at least one of the first linear transportation path and the second linear transportation path.

4. A loadlock chamber (130) for loading and unloading a substrate (131) into and out of an inline substrate processing system (100) and being adapted for being arranged between a first processing chamber (110) and a second processing chamber (120) of the

inline substrate processing system such that the substrate may be moved along a first linear transportation path (114) into the first processing chamber and along a second linear transportation path (124) into the second processing chamber.

5. The loadlock chamber (130) of claim 4, further including a first transfer opening (137) and a second transfer opening (139) adapted for allowing the substrate to move along the first linear transportation path into the first processing chamber and along the second linear transportation path into the second processing chamber.

6. The loadlock chamber (130) of any of claims 4 to 5, further including a loadlock chamber door (134) adapted to allow the substrate to be loaded into and unloaded from the loadlock chamber in an essentially vertical orientation.

7. The loadlock chamber (130) of claim 6, wherein the loadlock chamber door is further adapted to be moveable in a direction parallel to at least one of the first linear transportation path and the second linear transportation path.

8. The loadlock chamber (130) of any of claims 6 to 7, wherein the loadlock chamber door is adapted to be moveable in a direction perpendicular to at least one of the first linear transportation path and the second linear transportation path and/or wherein the loadlock chamber door is adapted to be moveable in a direction perpendicular to at least one of the first linear transportation path and the second linear transportation path together with a substrate carrier.

9. The loadlock chamber (130) of any of claims 6 to 8, wherein the loadlock chamber door is adapted to be moveable in a direction parallel to a vertical axis of the loadlock chamber.

10. The loadlock chamber (130) of any of claims 6 to 9, wherein the loadlock chamber door is adapted to be tilted away from the loadlock chamber and towards the loadlock chamber.

11. The loadlock chamber (130) of claim 10, wherein the loadlock chamber door is adapted to be tilted away from the loadlock chamber and towards the loadlock chamber together with the substrate.

12. The loadlock chamber (130) of any of claims 10 to 11, wherein the loadlock chamber door is further adapted to be tilted away from the loadlock chamber and towards the loadlock chamber together with a swing station.

13. A method (1100) of operating an inline substrate processing system including a first processing chamber, a second processing chamber and a loadlock chamber, wherein the loadlock chamber is between the first processing chamber and the second processing chamber, the method including

- transporting (1110) a first substrate from the loadlock chamber into the first processing chamber and depositing a material layer on the first substrate; and
- transporting (1120) the first substrate to the second processing chamber via the loadlock chamber and depositing a further material layer on the first substrate or transporting (1130) the first substrate to the loadlock chamber

and transporting a second substrate into the second processing chamber and depositing a material layer on the second substrate.

14. The method of claim 13, further including loading (1150) the first substrate and/or the second substrate into the inline substrate processing system in a direction perpendicular to the transport direction of the first substrate, the transport direction of the first substrate being defined as the linear path of the first substrate being transported from the loadlock chamber to the first processing chamber.

15. An inline substrate processing system (130) for processing an essentially vertically-oriented substrate (131), comprising:

a first processing chamber (110) having a first processing region (116) and being adapted to deposit a first material layer on the substrate;

a second processing chamber (120) having a second processing region (126) and being adapted to deposit a second material layer on the substrate; and

a loadlock chamber (130) adapted to load and unload the substrate in an essentially vertical orientation from the inline substrate processing system,

wherein the loadlock chamber is between the first processing chamber and the second processing chamber such that the substrate may be transported to the first processing region along a first linear transportation path (114) and to the second processing region along a second linear transportation path (124).

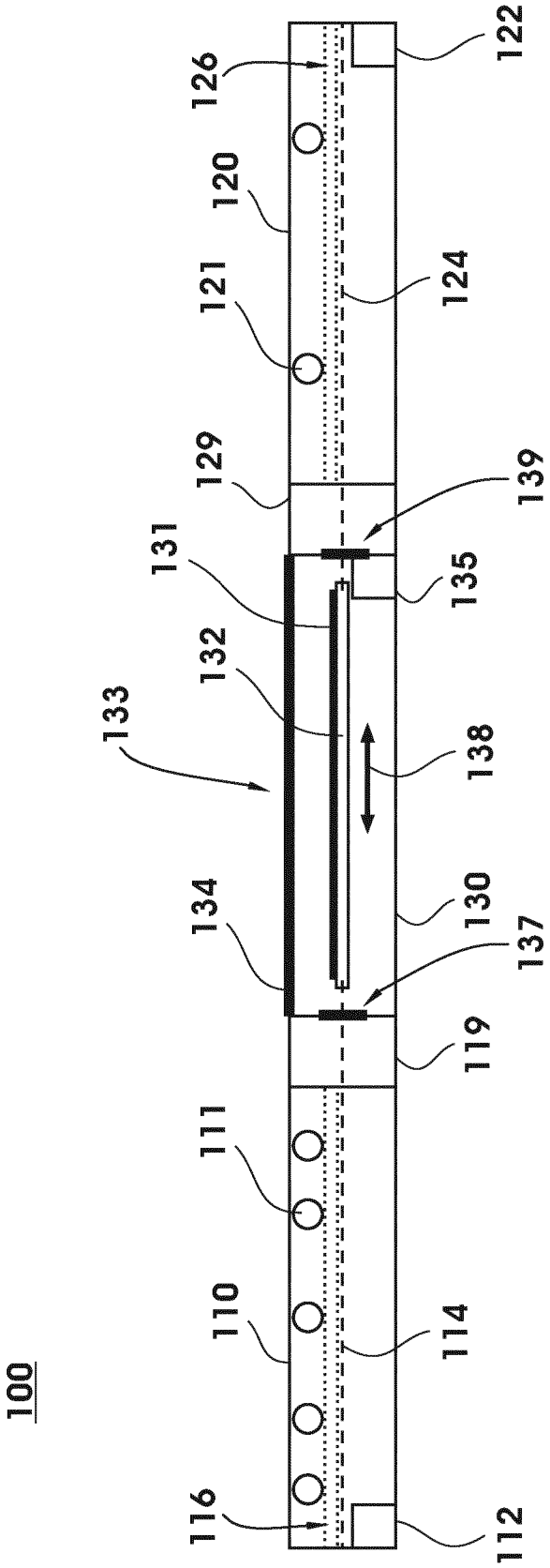

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Fig. 1

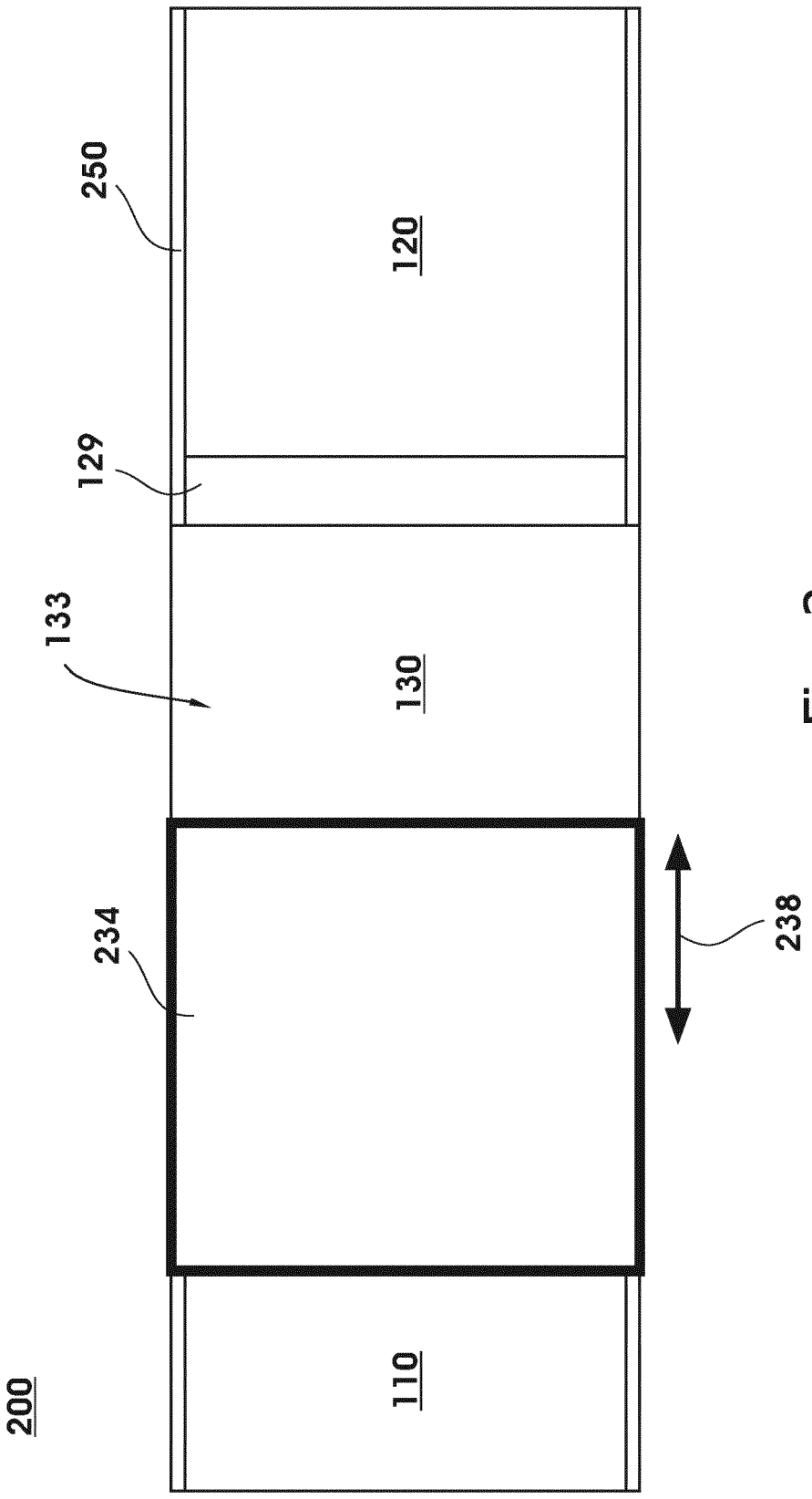


Fig. 2

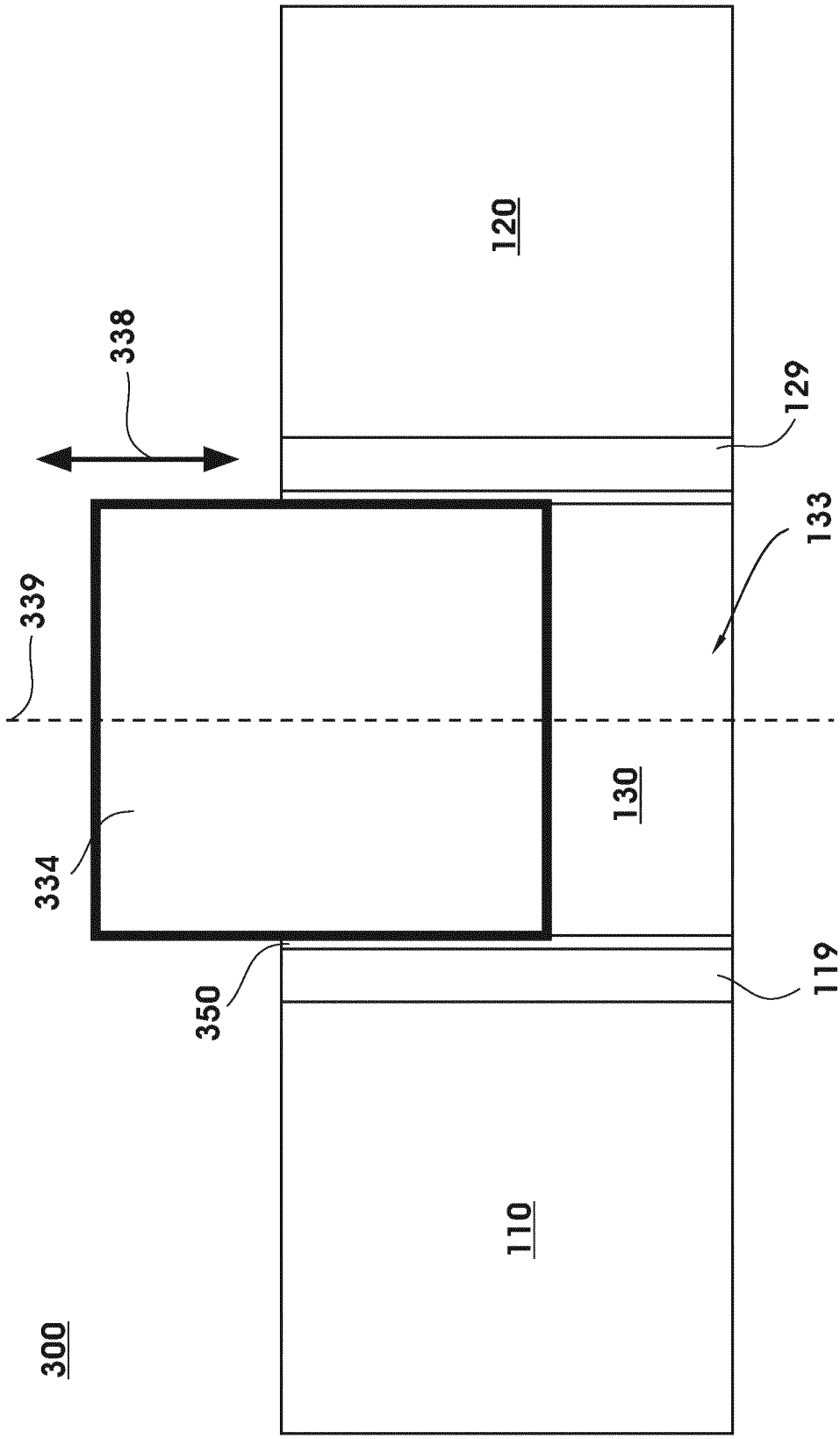


Fig. 3

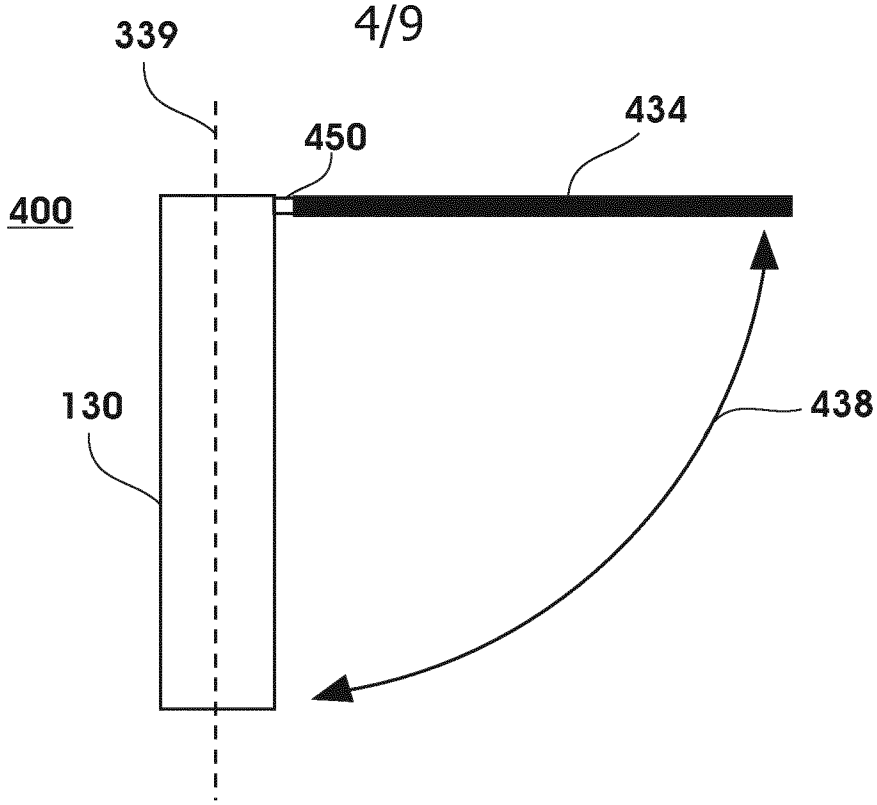


Fig. 4

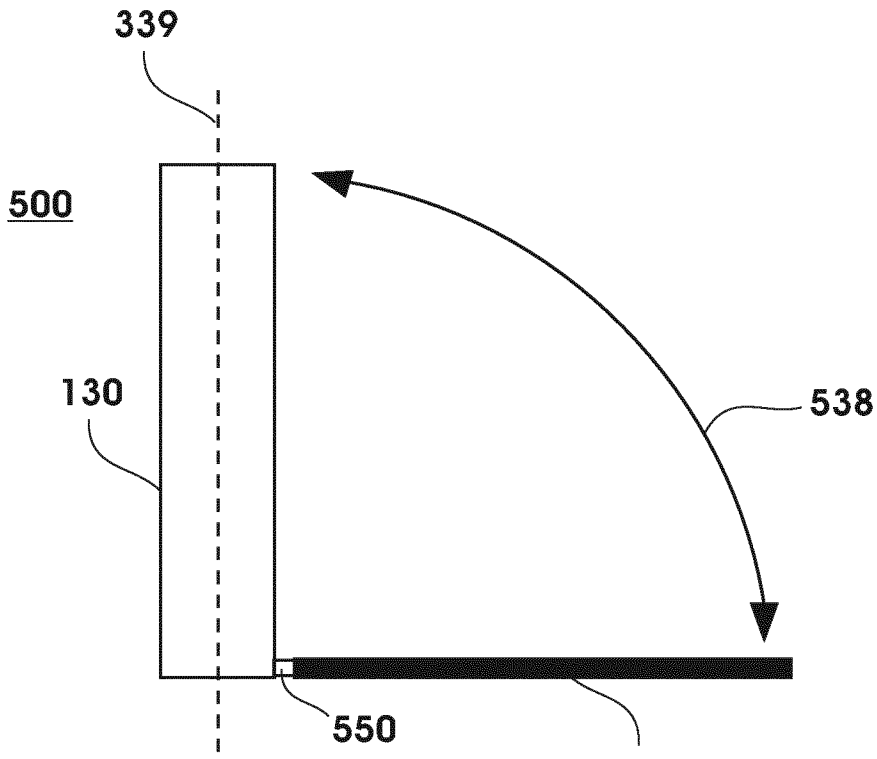


Fig. 5

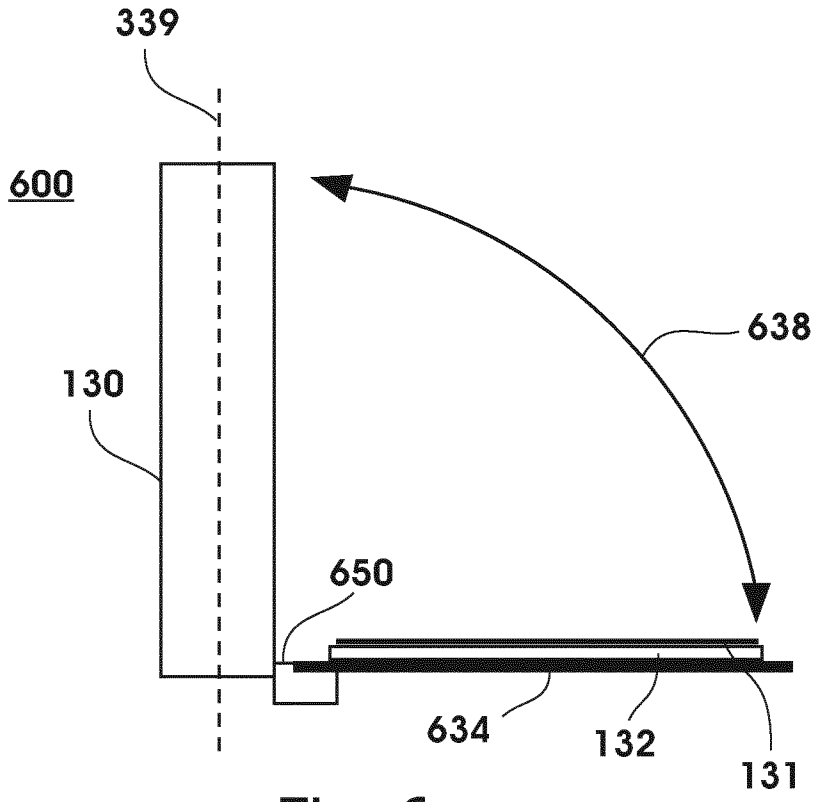


Fig. 6

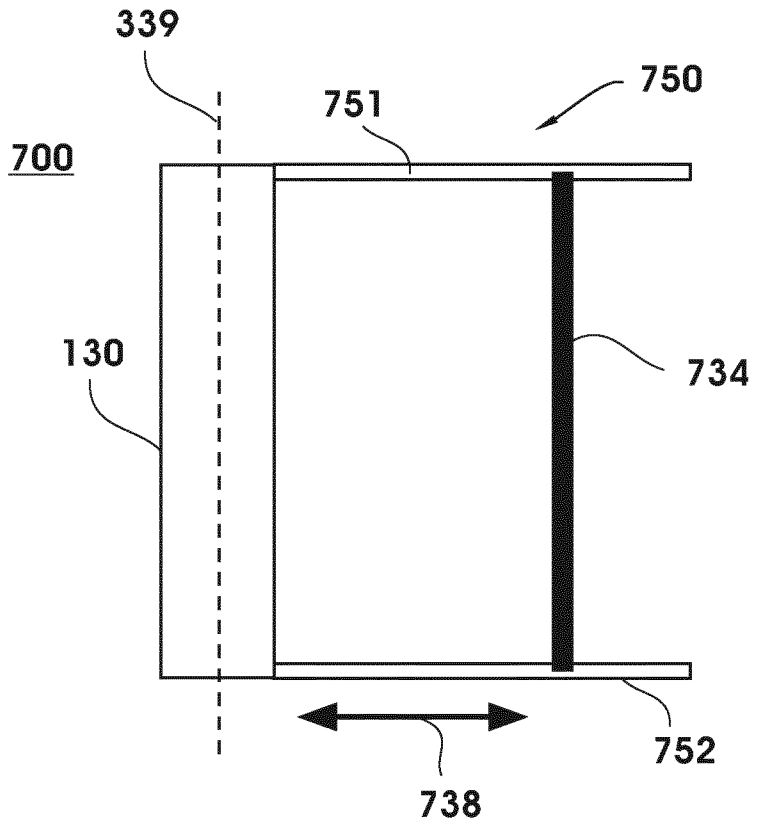


Fig. 7

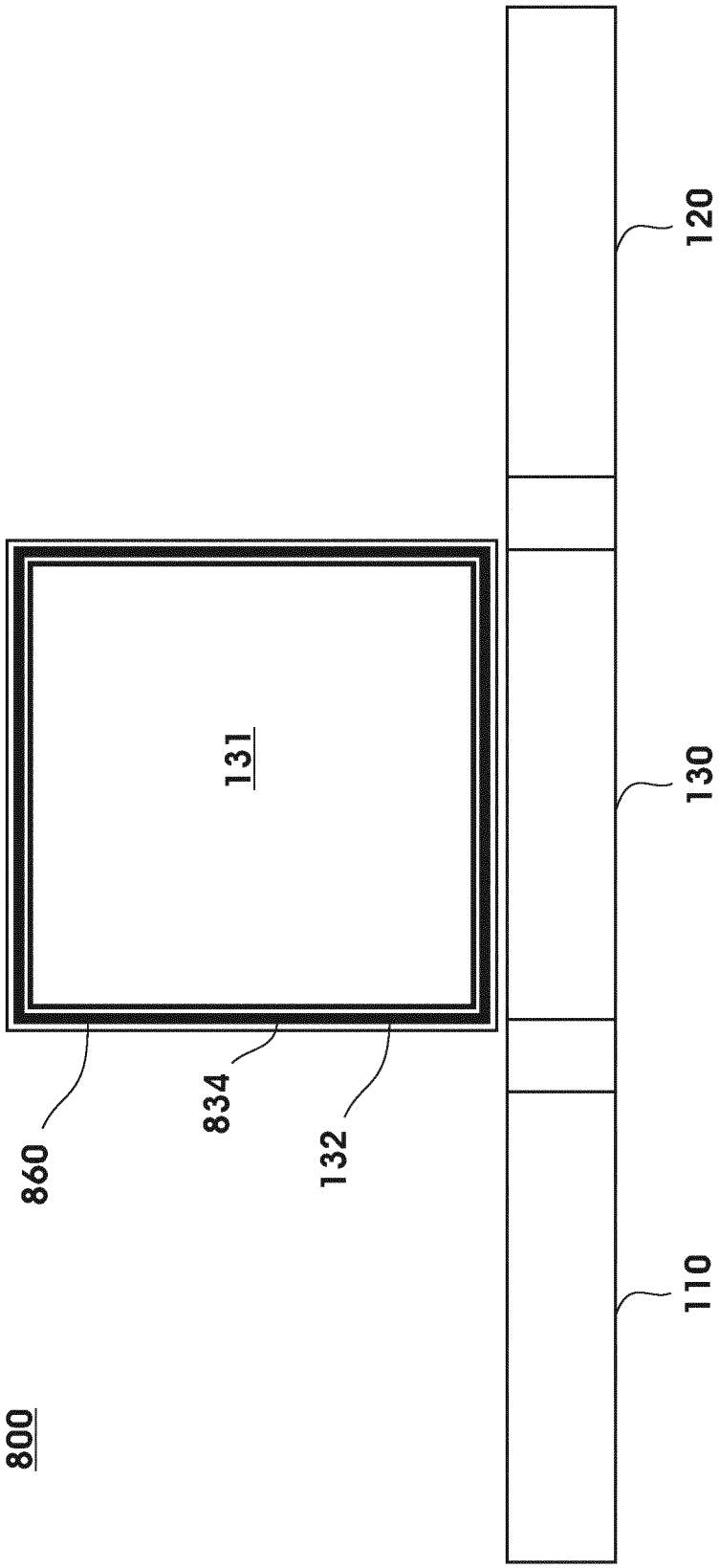


Fig. 8

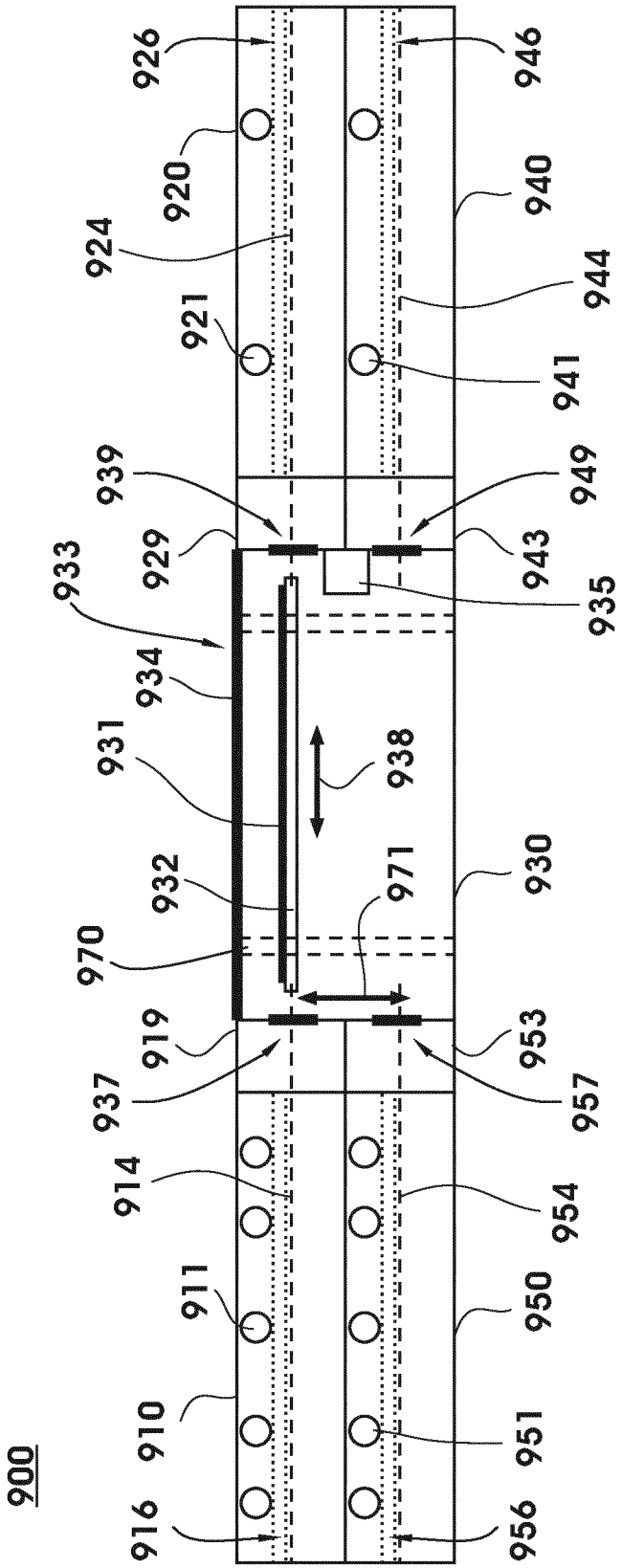

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Fig. 9

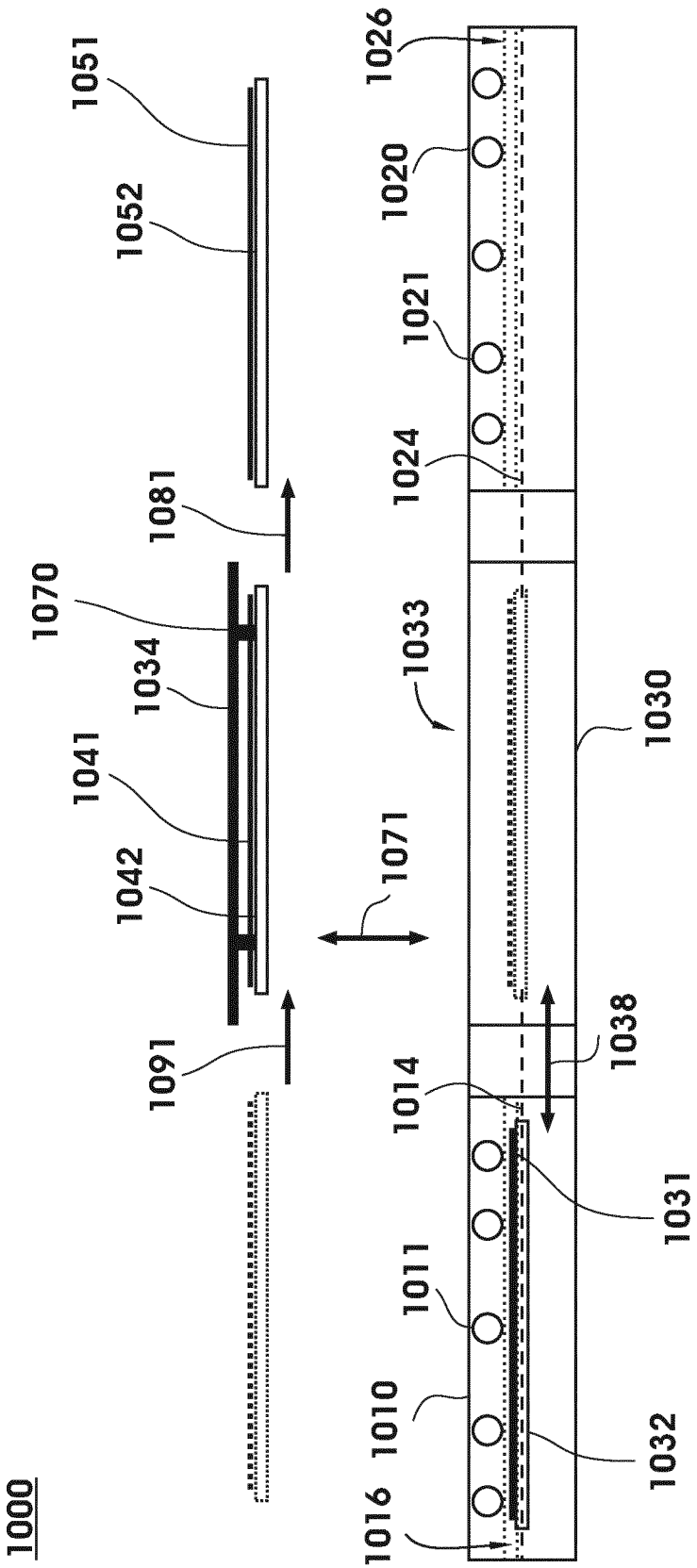

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Fig. 10

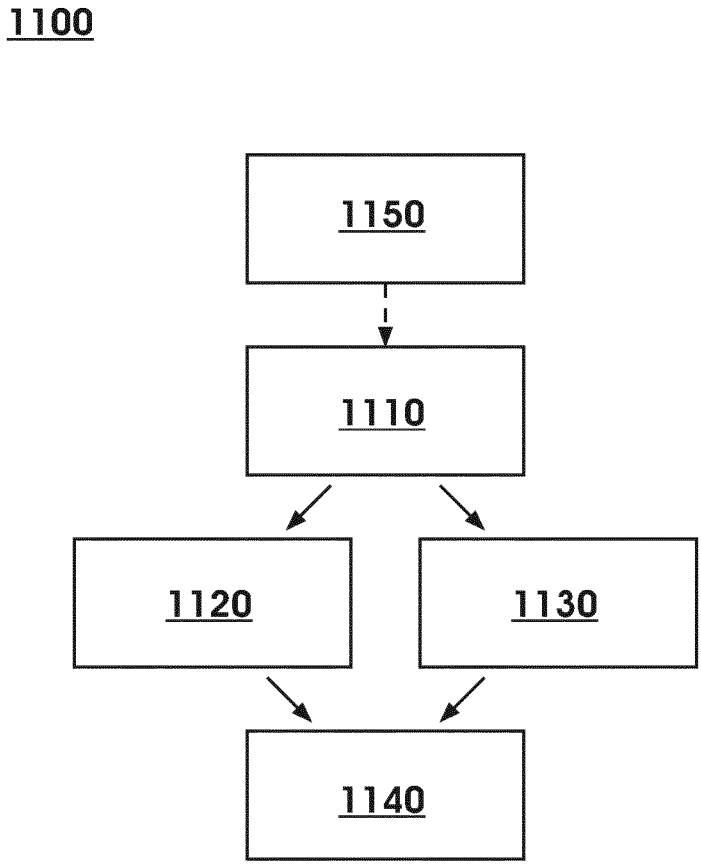


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/061414

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L21/67
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)
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	US 2006/026857 A1 (KIM KI-SANG [KR] ET AL) 9 February 2006 (2006-02-09)	4,5
Y	abstract; figures 4,7,8 paragraphs [0051], [0057]	1-3,6-15
Y	EP 2 489 759 A1 (APPLIED MATERIALS INC [US]) 22 August 2012 (2012-08-22)	1-3,6-15
A	paragraph [0056]; figure 1	4
A	US 6 024 800 A (SOEJIMA YUKIO [JP] ET AL) 15 February 2000 (2000-02-15) abstract; figure 1	1,4,13, 15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"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	Date of mailing of the international search report
18 January 2016	29/01/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Oberle, Thierry

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2015/061414

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