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SUBSTRATE PROCESSING APPARATUS

Abstract

The present invention relates to a substrate processing apparatus in which a material adsorbed onto a tray undergoes a process. One embodiment of the present invention provides a substrate processing apparatus including a tray having an adsorption maintenance space formed therein, a driving unit configured to allow the tray to successively pass through a plurality of process sections, a low pressure forming unit positioned at one side of the driving unit at a position before the tray enters the plurality of process sections and configured to discharge a fluid from the adsorption maintenance space to form a pressure difference between the adsorption maintenance space and the outside, and a pressure difference removing unit disposed at one side of the driving unit at a position at which all of the plurality of process sections end and configured to inject a fluid into the adsorption maintenance space, wherein the tray adsorbs a material using the pressure difference.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority and the benefit of Korean Patent Application No. 10-2024-0024588, filed on Feb. 20, 2024 in the Korean Intellectual Property Office, the entire disclosure of which is incorporated herein by reference.

BACKGROUND

1. Field of the Invention

[0002] The present invention relates to a substrate processing apparatus, and more specifically, to a substrate processing apparatus in which a material adsorbed onto a tray undergoes a process.

2. Discussion of Related Art

[0003] A substrate processing apparatus is an apparatus in which a material used in product manufacturing is loaded and passes through at least one product manufacturing process to cause the material to undergo the process. There are various methods of transferring a material in a substrate processing apparatus. A tray may be moved in a state in which a material is simply placed on the tray, or a material may be moved while fixed with a fixing member such as a chuck. Alternatively, a material may be adsorbed onto a tray and the tray may be moved.

[0004] Among these, transfer through adsorption is widely used because it takes relatively little time to attach or detach a material and is more stable than simple placement. However, somewhat complex equipment is required to maintain a state in which a material is adsorbed onto a tray.

[0005] Meanwhile, when a material undergoes a plurality of processes, it is necessary to set a material movement speed required for each process differently according to the characteristics of each process. However, existing methods of transferring materials using belts or rollers have a problem in that it is difficult to set a material movement speed differently for each process.

[0006] The information in the background art described above was obtained by the inventors for the purpose of developing the present disclosure or was obtained during the process of developing the present disclosure. As such, it is to be appreciated that this information did not necessarily belong to the public domain before the patent filing date of the present disclosure.

SUMMARY OF THE INVENTION

[0007] The present invention is directed to providing a substrate processing apparatus that maintains an adsorption state of a material using a tray having an adsorption maintenance space and includes a driving unit capable of setting a movement speed of the material differently for each process.

[0008] However, the objects are exemplary, and the objects to be solved by the present invention are not limited thereto. Objects which are not described herein should be clearly understood by those skilled in the art from the following detailed description and the accompanying drawings.

[0009] According to an aspect of the present invention, there is provided a substrate processing apparatus including a tray having an adsorption maintenance space formed therein, a driving unit configured to allow the tray to successively pass through a plurality of process sections, a low pressure forming unit positioned at one side of the driving unit at a position before the tray enters the plurality of process sections and configured to discharge a fluid from the adsorption maintenance space to form a pressure difference between the adsorption maintenance space and the outside, and a pressure difference removing unit disposed at one side of the driving unit at a position at which all of the plurality of process sections end and configured to inject a fluid into the

adsorption maintenance space, wherein the tray adsorbs a material using the pressure difference.
[0010] The material may move through each of the plurality of process sections for a movement time set for each of the plurality of process sections, and the movement times may all be different or some may be equal among the plurality of process sections.
[0011] A movement speed at which the driving unit moves the tray may be different for each of the plurality of process sections.
[0012] The tray may further include a support on which the material is placed, the support may include an adsorption surface which is in in contact with one surface of the material to adsorb the material, and an area of the adsorption surface may be smaller than that of the one surface of the material with which the adsorption surface is in contact.
[0013] The tray may further include at least one adsorption hole formed in the adsorption surface and connected to the adsorption maintenance space, a flow path entrance that closes when separated from the low pressure forming unit and the pressure difference removing unit, and a connection flow path configured to connect the adsorption maintenance space and the flow path entrance.
[0014] The tray may further include an adsorption groove formed in the adsorption surface and extending from the adsorption hole.
[0015] The support may further include an adsorption auxiliary member, and the adsorption auxiliary member may include a second adsorption hole which is formed in an area corresponding to the adsorption hole and communicates with the adsorption hole.
[0016] The tray may further include a plurality of through-holes through which a plurality of lift pins configured to lift the material pass, and the through-holes may be spaced apart from the adsorption maintenance space.
[0017] The low pressure forming unit may include a plurality of low pressure forming units, and each of the plurality of low pressure forming units may be positioned at a position before the tray enters one of the plurality of process sections.
[0018] The pressure difference formed by some or all of the plurality of low-pressure forming units may be different.
[0019] The plurality of process sections may include a first process section in which a plasma treatment process is performed on the material, a second process section in which a rinse process is performed on the material, a third process section in which a first drying process is performed on the material, a fourth process section in which a coating process is performed on the material, and a fifth process section in which a second drying process is performed on the material, wherein the coating process includes a process of coating the material with a self-assembled monolayer (SAM) material.
[0020] Aspects, features, and advantages other than those described above will become apparent from the following detailed description, claims and drawings for embodying the present invention.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0021] The above and other objects, features and advantages of the present invention will become more apparent to those of ordinary skill in the art by describing exemplary embodiments thereof in detail with reference to the accompanying drawings, in which:
[0022] FIG. **1** is a perspective view illustrating a substrate processing apparatus according to one embodiment of the present invention;
[0023] FIG. **2** is a front view illustrating the substrate processing apparatus according to one embodiment of the present invention;
[0024] FIG. **3** is a plan view illustrating the substrate processing apparatus according to one

embodiment of the present invention;
[0025] FIG. **4** is a cross-sectional view along line I-I′ of FIG. **3** and illustrates a tray according to one embodiment of the present invention;
[0026] FIG. **5** is a view illustrating a difference in size between a material to be transferred by the substrate processing apparatus according to one embodiment of the present invention and an adsorption surface according to one embodiment of the present invention;
[0027] FIG. **6** is a view illustrating a portion of the tray according to one embodiment of the present invention;
[0028] FIG. **7** is a view illustrating a tray including an adsorption auxiliary member according to one embodiment of the present invention;
[0029] FIG. **8** shows a view illustrating a portion of a tray and a cross-sectional view along line II-II′ according to another embodiment of the present invention;
[0030] FIG. **9** is a view illustrating a portion of a tray according to still another embodiment of the present invention;
[0031] FIG. **10** shows views illustrating a process of separating a material from the tray in sequence through a cross section of the tray along line III-III′ of FIG. **9**;
[0032] FIG. **11** is a plan view illustrating a substrate processing apparatus according to another embodiment of the present invention; and
[0033] FIG. **12** is a diagram illustrating a movement speed and a pressure difference according to a position of a material in the substrate processing apparatus according to another embodiment of the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0034] Since the present invention can apply various transformations and have various embodiments, specific embodiments will be illustrated in the accompanying drawings and described in detail in the detailed description. However, it should be understood that this is not intended to limit the present invention to specific embodiments, and all transformations, equivalents, and substitutions included in the spirit and scope of the present invention are included. In the description of the present invention, even when illustrated in other embodiments, like reference numerals refer to like components.
[0035] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings, wherein like reference numerals refer to the same or corresponding components throughout the drawings, and redundant description thereof will be omitted.
[0036] In the following embodiments, the terms “first,” “second,” and the like do not have limiting meanings but are used for the purpose of distinguishing one component from another component.
[0037] In the following embodiments, the expressions used in the singular such as “a” and “an” are intended to include the plural forms as well, unless the context clearly indicates otherwise.
[0038] In the following embodiments, it will be understood that terms such as “including,” “comprising,” and “having” specify the presence of stated features or components, but do not preclude the presence or addition of one or more other features or components.
[0039] In the drawings, components may be exaggerated or reduced in size for convenience of description. For example, the sizes and thicknesses of the respective components shown in the drawings are arbitrarily shown for convenience of description, and thus the present invention is not necessarily limited thereto.
[0040] In the following embodiments, an X-axis, a Y-axis, and a Z-axis are not limited to three axes in an orthogonal coordinate system and may be interpreted in a broad sense that includes the three axes. For example, the X-axis, Y-axis, and Z-axis may be orthogonal to each other, or may be oriented in different directions that are not orthogonal to each other.
[0041] When a certain embodiment may be implemented differently, a specific process order may be performed differently from the described order. For example, two consecutively described processes may be performed substantially at the same time or may be performed in an order

opposite to the described order.
[0042] The terms used herein are merely used to describe specific embodiments and are not intended to limit the disclosure. In the present application, the word “comprise” or “have” is used to specify the existence of a feature, a number, a process, an operation, a constituent element, a part, or a combination thereof, and it will be understood that the existence or additional possibility of one or more other features, numbers, processes, operations, constituent elements, parts, or combinations thereof are not excluded in advance.
[0043] In the following embodiments, it will be understood that when an element such as a layer, film, region, or substrate is referred to as being connected to another element, it can be directly connected to the other element or intervening elements may also be present. For example, in the present specification it will be understood that when an element such as a layer, film, region, or substrate is referred to as being electrically connected to another element, it can be electrically connected directly to the other element or intervening elements may also be present.
[0044] Hereinafter, a substrate processing apparatus according to an embodiment of the present invention will be described with reference to FIGS. **1** to **12**.
[0045] FIG. **1** is a perspective view illustrating a substrate processing apparatus **1** according to one embodiment of the present invention. FIG. **2** is a front view illustrating the substrate processing apparatus **1** according to one embodiment of the present invention. FIG. **3** is a plan view illustrating the substrate processing apparatus **1** according to one embodiment of the present invention.
[0046] The substrate processing apparatus **1** is an apparatus in which a material W used in product production is loaded and passes through a plurality of product manufacturing processes to cause the material W to undergo a plurality of processes. A type of a product manufactured by the substrate processing apparatus **1** is not particularly limited. In one embodiment, the product may include a semiconductor or a solar cell. The material W that is a transfer target of the substrate processing apparatus **1** is likewise not particularly limited. In one embodiment, the material W may include a substrate (wafer). Referring to FIG. **1**, the substrate processing apparatus **1** may include a driving unit **100**, a low pressure forming unit **200**, a pressure difference removing unit **300**, and a tray **400**.
[0047] The driving unit **100** may allow the tray **400** to be described below to sequentially pass through a plurality of process sections P. The plurality of process sections P are sections in which a set of processes that should be sequentially performed on the material W are performed. For example, referring to FIG. **2**, the plurality of process sections P may include a first process section P**1**, a second process section P**2**, a third process section P**3**, a fourth process section P**4**, and a fifth process section P**5**. However, this is merely an example for describing the present invention, and the present invention is not limited thereto. That is, the number of processes included in the plurality of process sections P is not particularly limited.
[0048] The driving unit **100** may include a guide block **110**, a transfer block **120**, a return guide block **130**, a lowering block **140**, and a lifting block **150**.
[0049] The guide block **110** may sequentially pass through the plurality of process sections P and may guide a movement path of the tray **400**. That is, the guide block **110** may be disposed parallel to an arrangement direction of the plurality of process sections P. For example, referring to FIG. **2**, the plurality of process sections P may be arranged in an X-axis direction. In this case, the guide block **110** may extend parallel to the X-axis.
[0050] The transfer block **120** may be connected to an upper end of the guide block **110** to move along the guide block **110**. Referring to FIGS. **1** and **3**, the tray **400** to be described below may be fixed to one end of the transfer block **120**. That is, the tray **400** may be fixed to the transfer block **120** and moved along the guide block **110** by the transfer block **120**.
[0051] The material W may move for a set movement time in one process section P and move to a subsequent process section P. Specifically, the material W may move between a start point and an end point (a start point of a subsequent process section P) of one process section P for a set

movement time. That is, the material W may be moved through each of the plurality of process sections P, and a process may be performed for a set movement time. That is, a movement time may be considered as a process time in each process. For example, the process times in the plurality of process sections P may be different, and the process times in some process sections P may be equal to each other.

[0052] A movement speed v at which the driving unit **100** moves the tray **400** may be different for each of the plurality of process sections P. Since the tray **400** is fixed to the transfer block **120**, the movement speed v of the tray **400** is a movement speed of the transfer block **120**. Each tray **400** may have different movement speeds v at the same time. In addition, the movement speed v of one tray **400** may be changed according to a current moment position. Since speed control is possible for each process section P, there is no need to secure a transfer distance for speed compensation for each process, and a size of equipment can be reduced.

[0053] For a specific example, as shown in FIG. **2**, a first movement speed v**1** of a first tray **400***a*, a second movement speed v**2** of a second tray **400**B, a third movement speed v**3** of a third tray **400**C, a fourth movement speed v**4** of a fourth tray **400***d*, and a fifth movement speed v**5** of a fifth tray **400***e* may all be different at the same time. In addition, the movement speed v of one tray **400** may be the first movement speed v**1** in the first process section P**1**, may be changed to the second movement speed v**2** in the second process section P**2**, may be changed to the third movement speed v**3** in the third process section P**3**, may be changed to the fourth movement speed v**4** in the fourth process section P**4**, and may be changed to the fifth movement speed v**5** in the fifth process section P**5**.

[0054] In one embodiment, the guide block **110** and the transfer block **120** may each include a linear motion system (LMS). That is, the guide block **110** may include an electromagnet of which magnetic strength is changed according to a change in current. The transfer block **120** may include a permanent magnet. By controlling a current of the electromagnet included in a portion of the guide block **110** with which the transfer block **120** is in contact, the movement speed v of the tray **400** may be set differently for each transfer block **120**. However, this is merely an example, and a principle behind changing the movement speed v of the tray **400** for each of the plurality of process sections P is not limited thereto.

[0055] In another embodiment, the movement speed v of the tray **400** may be the same in all of the process sections P, and lengths of the process sections P may be different. Accordingly, there is no need to control a speed of the tray **400** according to the process section P, and thereby the number of components such as a driving unit and a control unit for controlling the speed of the tray **400** can be minimized.

[0056] For a specific example, although not shown in the drawings, lengths of the first to fifth process sections P**1** to P**5** may all be different, or lengths of some process sections P may be equal to each other. The first process section P**1** may have a first length, the second process section P**2** may have a second length, the third process section P**3** may have a third length, the fourth process section P**4** may have a fourth length, and the fifth process section P**5** may have a fifth length. In this case, the first to fifth lengths may be different. In addition, some of the first to fifth lengths may be equal to each other, and others may be different. Here, the length of the process section is a length of the tray **400** in a process passage direction (X-axis).

[0057] The return guide block **130** may move the tray **400**, which has passed through all of the plurality of process sections P, back to an initial position of the plurality of process sections P. The return guide block **130** may be parallel to the guide block **110** at a lower end of the guide block **110**. The movement speed of the tray **400** on the return guide block **130** is not particularly limited.

[0058] Referring to FIGS. **1** and **2**, the lowering block **140** may move the tray **400**, which has passed through the plurality of process sections P, from the guide block **110** to the return guide block **130**. In one embodiment, in a state in which the transfer block **120** is coupled onto an auxiliary block having the same cross section as the guide block **110** and the return guide block

130, the lowering block **140** may be moved in such a manner that the auxiliary block moves along a rail disposed on the lowering block **140** in a Z-axis direction. However, a method in which the lowering block **140** moves the tray **400** is not limited thereto.

[0059] Referring to FIGS. **1** and **2**, the lifting block **150** may move the tray **400** moved along the return guide block **130** to the guide block **110**. A moving direction of the tray **400** on the lifting block **150** may be opposite to a moving direction of the tray **400** on the lowering block **140**. A principle of movement of the tray **400** on the lifting block **150** may be the same as or similar to the above-described principle of movement of the tray **400** on the lowering block **140**.

[0060] Since the driving unit **100** includes the return guide block **130**, the lowering block **140**, and the lifting block **150**, a limited number of trays **400** can be used repeatedly, and a size of equipment can be reduced, which is economical.

[0061] The tray **400** may be circulated by the driving unit **100**. Referring to FIGS. **1** to **3**, describing the overall circulation flow, the material W may be placed on the tray **400** just before the tray **400** enters the guide block **110** or before the plurality of process sections P start. The tray **400** on which the material W is placed may move along the guide block **110** to pass through the plurality of process sections P. After passing through all of the plurality of process sections P, the material W may be lifted from the tray **400** and moved to a subsequent process. In this case, in one embodiment, the material W may be lifted from the tray **400** by a lift pin LP (see FIG. **10**). The tray **400** separated from the material W may sequentially pass the lowering block **140**, the return guide block **130**, and the lifting block **150** to return to a position before the plurality of process sections P start.

[0062] The low pressure forming unit **200** may form a low pressure inside the tray **400** such that the material W is adsorbed onto the tray **400**. Specifically, the low pressure forming unit **200** may discharge a fluid from an adsorption maintenance space **430** to be described below to form a pressure difference ΔP between the adsorption maintenance space **430** and the outside. The fluid may fill the adsorption maintenance space **430** and may serve as a medium that changes the pressure of the adsorption maintenance space **430**. In one embodiment, the fluid may include air.

[0063] Referring to FIG. **3**, the low pressure forming unit **200** may be positioned at one side of the driving unit **100** at a position before the tray **400** enters the plurality of process sections P. The low pressure forming unit **200** may may be coupled to a flow path entrance **440** to be described below and connected to the adsorption maintenance space **430**.

[0064] In one embodiment, with respect to the guide block **110**, the low pressure forming unit **200** may be disposed in a direction opposite to a space to which the material W moves. That is, referring to FIG. **3**, with respect to the guide block **110** extending in the X-axis direction, the low pressure forming unit **200** may be disposed in a direction opposite to a space (Y-axis direction) to which the material W moves. Accordingly, the low pressure forming unit **200** can be prevented from interfering with or interrupting the movement of the material W, and an arrangement design between components can be simplified.

[0065] The pressure difference removing unit **300** may serve to remove the pressure difference ΔP between the inside and the outside of the tray **400** such that the material W may be separated from the tray **400** and a state in which the material W is adsorbed onto the tray **400** may be terminated. Specifically, the pressure difference removing unit **300** may remove the pressure difference ΔP between the adsorption maintenance space **430** and the outside by injecting a fluid into the adsorption maintenance space **430**. The pressure difference removing unit **300** may be coupled to the flow path entrance **440** to be described below and connected to the adsorption maintenance space **430**.

[0066] Referring to FIG. **3**, the pressure difference removing unit **300** may be disposed at one side of the driving unit **100** at a position at which the plurality of process sections P all end. Accordingly, the material W that has passed through all of the plurality of process sections P may be lifted by the lift pin LP.

[0067] In one embodiment, the pressure difference removing unit **300** may be disposed in the same direction as the low pressure forming unit **200** with respect to the guide block **110**. In other words, with respect to the guide block **110**, the pressure difference removing unit **300** may be disposed in a direction opposite to a space to which the material W moves. Such an effect is identical or similar to that described for the low pressure forming unit **200** and thus is omitted.
[0068] FIG. **4** is a cross-sectional view along line I-I′ of FIG. **3** and illustrates the tray **400** according to one embodiment of the present invention. FIG. **5** is a view illustrating a difference in size between the material W to be transferred by the substrate processing apparatus **1** according to one embodiment of the present invention and an adsorption surface **421** according to one embodiment of the present invention. FIG. **6** is a view illustrating a portion of the tray **400** according to one embodiment of the present invention.
[0069] The tray **400** may serve to transfer the material W. The tray **400** may transfer the material W while adsorbing the material W. The tray **400** may adsorb material W using the pressure difference ΔP. Specifically, the tray **400** may have the adsorption maintenance space **430** therein. More specifically, the tray **400** may include a tray body **410**, a support **420**, the adsorption maintenance space **430**, the flow path entrance **440**, a connection flow path **450**, and an adsorption hole **460**.
[0070] One end of the tray body **410** may be fixed to the transfer block **120**. The adsorption maintenance space **430** to be described below may be formed inside the tray body **410**.
[0071] The support **420** may lift and hold the material W. The support **420** may be provided on an upper end of the tray body **410**. The support **420** may separate the material W from the tray body **410**. A plurality of supports **420** may be disposed on the tray body **410**. Referring to FIGS. **1** and **3**, although two supports **420** are disposed in a direction (Y-axis) perpendicular to the process passage direction (X-axis) of the tray **400**, this is merely one embodiment, and an arrangement shape of the supports **420** is not limited thereto.
[0072] The support **420** may be made of a rigid or elastic material. For example, the support **420** may be made of at least one material selected from a metal, a ceramic, a resin, and rubber. In one embodiment, the support **420** may be made of an elastic material. Accordingly, when one surface of the material W in contact with the adsorption surface **421** to be described below is patterned, a pattern may be prevented from being damaged by contact between the adsorption surface **421** and the material W.
[0073] The support **420** may include the adsorption surface **421**. The adsorption surface **421** may be an upper surface of the support **420**. The adsorption surface **421** may be in contact with one surface of the material W. The adsorption surface **421** may adsorb the material W.
[0074] The adsorption surface **421** may be flat and smooth without any protruding portions. Accordingly, an adsorption force of the adsorption surface **421** for the material W can be improved.
[0075] An area of the adsorption surface **421** may be smaller than an area of one surface of the material W in contact therewith. Specifically, referring to FIG. **5**, a length **421**D of one side of the adsorption surface **421** may be smaller than a length WD of one side of the material W corresponding thereto. Among a plurality of processes, there may be a process of coating one surface of the material W by spraying a coating liquid from above the material W. In this case, since the area of the adsorption surface **421** is smaller than that of one surface of the material W, the coating liquid is not sprayed on the adsorption surface **421**, and thereby a phenomenon of the coating liquid contaminating one surface of the material W that comes into contact with the adsorption surface **421** when the tray **400** is re-introduced into the plurality of process sections P is prevented. In addition, since the coating liquid is not sprayed on the adsorption surface **421**, the adsorption surface **421** can be maintained in a flat state while the adsorption hole **460** to be described below is prevented from being clogged. Accordingly, an adsorption force of the adsorption surface **421** for the material W can be maintained.
[0076] The adsorption maintenance space **430** may be an internal space of the tray **400** in which the pressure difference ΔP with the outside is formed such that the material W remains adsorbed onto

the tray **400**. Specifically, the adsorption maintenance space **430** may be formed inside the tray body **410**. The adsorption maintenance space **430** may be formed below the support **420**. The shape and volume of the adsorption maintenance space **430** are not particularly limited.

[0077] The adsorption maintenance space **430** may be a closed space except that the adsorption maintenance space **430** is connected to the connection flow path **450** and the adsorption hole **460** which will be described below. In other words, the adsorption maintenance space **430** may be in an airtight state except that the adsorption maintenance space **430** is connected to the connection flow path **450** and the adsorption hole **460**.

[0078] The effect of the existence of the adsorption maintenance space **430** will be described below.

[0079] The flow path entrance **440** may serve as a fluid entrance through which a fluid is discharged from the adsorption maintenance space **430** or is discharged into the adsorption maintenance space **430**. The flow path entrance **440** may be attached to or detached from the low pressure forming unit **200** and the pressure difference removing unit **300**. When the flow path entrance **440** is coupled to the low pressure forming unit **200**, a fluid may be discharged from the adsorption maintenance space **430** to the low pressure forming unit **200**. When the flow path entrance **440** is coupled to the pressure difference removing unit **300**, a fluid may be injected from the pressure difference removing unit **300** into the adsorption maintenance space **430**.

[0080] On the other hand, the flow path entrance **440** may be closed when separated from the low pressure forming unit **200** and the pressure difference removing unit **300**. Accordingly, when the tray **400** is separated from the low pressure forming unit **200** and the pressure difference removing unit **300** and passes through the process section P, air can be prevented from being suctioned into the adsorption maintenance space **430** through the flow path entrance **440**.

[0081] In one embodiment, the flow path entrance **440** may include a check valve or a one-way valve.

[0082] Referring to FIG. **4**, the flow path entrance **440** may be disposed at one side of the transfer block **120**. Specifically, the flow path entrance **440** may be disposed in a direction opposite to a surface of the transfer block **120** to which the tray body **410** is fixed. Accordingly, the flow path entrance **440** may be smoothly attached to or detached from the low pressure forming unit **200** and the pressure difference removing unit **300** which are positioned in a direction opposite to a space in which the material W moves with respect to the guide block **110**.

[0083] The connection flow path **450** may connect the adsorption maintenance space **430** and the flow path entrance **440**. That is, through the connection flow path **450**, the low pressure forming unit **200** and the pressure difference removing unit **300** may be connected to the adsorption maintenance space **430**. The connection flow path **450** is illustrated as passing through the transfer block **120** in FIG. **4**, but a specific path of the connection flow path **450** is not particularly limited. In one embodiment, the connection flow path **450** may include a pipe (not shown) that protrudes from the tray body **410** to be connected to the flow path entrance **440**.

[0084] Referring to FIGS. **4** to **6**, the adsorption hole **460** may be formed in the adsorption surface **421**. The adsorption hole **460** may pass through the support **420**. The adsorption hole **460** may be connected to the adsorption maintenance space **430**. That is, the pressure of the adsorption hole **460** may be equal to the pressure of the adsorption maintenance space **430**. Accordingly, the material W may be adsorbed onto the adsorption surface **421** by the pressure difference ΔP between the adsorption maintenance space **430** and the outside.

[0085] There may be at least one adsorption hole **460**. In other words, a plurality of adsorption holes **460** may be included. An arrangement relationship of the plurality of adsorption holes **460** on the adsorption surface **421** is not particularly limited. In one embodiment, regarding the arrangement relationship of the plurality of adsorption holes **460** on the adsorption surface **421**, as shown in FIGS. **5** and **6**, one adsorption hole **460** may be disposed at a central portion, and one adsorption hole **460** may be disposed near each vertex of the support **420**. However, this is merely an embodiment, and the arrangement relationship of the adsorption holes **460** on the adsorption surface **421** is not limited thereto.

[0086] A principle behind the material W being adsorbed onto the adsorption surface **421** is specifically as follows. When the material W comes into contact with the adsorption surface **421**, the adsorption hole **460** is blocked from the outside by the material W. In this case, as a fluid present inside the adsorption maintenance space **430** is discharged by the low pressure forming unit **200**, the pressure difference ΔP between the outside and the adsorption maintenance space **430** may be generated. Specifically, the outside is a space in a process which is separated from the adsorption maintenance space **430** by the tray body **410**. The external pressure may be equal to the pressure of the process section P. When a fluid is discharged from the adsorption maintenance space **430** by the low pressure forming unit **200**, the pressure of the adsorption maintenance space **430** may become lower than the external pressure. That is, the pressure difference ΔP may be generated, which may become a driving force with which the material W is adsorbed onto the adsorption surface **421**.

[0087] The effect of the existence of the adsorption maintenance space **430** is as follows.

[0088] After being connected to the low pressure forming unit **200** before entering the plurality of process sections P, the tray **400** may remain separated from the low pressure forming unit **200** while passing through the plurality of process sections P. Meanwhile, it is realistically difficult to completely maintain airtightness. Therefore, unless the low pressure forming unit **200** is continuously connected to adsorb the material W, it is difficult to maintain an adsorption force of the adsorption surface **421** for the material W.

[0089] To compensate for this, the adsorption maintenance space **430** may be disposed between the low pressure forming unit **200** and the adsorption hole **460**. By making a low-pressure state in the interior of the adsorption maintenance space **430** which has a relatively larger volume than the adsorption hole **460**, a time for an adsorption force of the adsorption surface **421** for the material W to decrease may be delayed (buffered). Accordingly, the material W may remain adsorbed onto the adsorption surface **421** while the tray **400** passes through the process section P.

[0090] FIG. **7** is a view illustrating a tray **400*a*** including an adsorption auxiliary member **423** according to one embodiment of the present invention.

[0091] The tray **400*a*** may include a tray body **410**, a support **420**A, an adsorption maintenance space **430**, a flow path entrance **440**, a connection flow path **450**, and an adsorption hole **460**. Among these, since the tray body **410**, the adsorption maintenance space **430**, the flow path entrance **440**, the connection flow path **450**, and the adsorption hole **460** are identical or similar to those described for the tray **400**, detailed descriptions will be omitted, and the differences will be mainly described. All components identical to those of the tray **400** shown in FIGS. **1** to **6** are assigned the same reference symbols in FIG. **7**.

[0092] Referring to FIG. **7**, the support **420**A may further include the adsorption auxiliary member **423**. The adsorption auxiliary member **423** may be disposed as one layer on an adsorption surface **421**. The adsorption auxiliary member **423** may be made of a material having a higher elastic strain than the support **420**A. The adsorption auxiliary member **423** may include a soft material. In one embodiment, the adsorption auxiliary member **423** may include rubber or silicone.

[0093] The adsorption auxiliary member **423** may include a second adsorption hole **423*a***. The second adsorption hole **423*a*** may communicate with the adsorption hole **460** formed in the adsorption surface **421** of the support **420**A. For this purpose, the second adsorption hole **423*a*** may be formed in an area corresponding to the adsorption hole **460**. For example, the second adsorption hole **423*a*** may be formed in an area overlapping the adsorption hole **460** in a Z-axis direction. In addition, the number of second adsorption holes **423*a*** may correspond to the number of adsorption holes **460**. In addition, the second adsorption hole **423*a*** may be provided to have a size corresponding to the adsorption hole **460**.

[0094] Protrusions pt are patterned on one surface of a material W′ in contact with the adsorption surface **421**. The adsorption auxiliary member **423** may be disposed between the material W′ and the adsorption surface **421**, and thus, as shown in FIG. **7**, the adsorption auxiliary member **423** may fill a gap between the material W′ and the adsorption surface **421** which is generated by the protrusion pt. Thus, a close contact state between the material W′ and the adsorption surface **421** may be maintained to maintain an adsorption force of the adsorption surface **421** for the material W′.

[0095] FIG. **8** shows a view illustrating a portion of a tray **400**B and a cross-sectional view along line II-II′ according to another embodiment of the present invention.

[0096] The tray **400**B may include a tray body **410**, a support **420**, an adsorption maintenance space **430**, a flow path entrance **440**, a connection flow path **450**, an adsorption hole **460**, and an adsorption groove **470**. Among these, since the tray body **410**, the support **420**, the adsorption maintenance space **430**, the flow path entrance **440**, the connection flow path **450**, and the adsorption hole **460** are identical or similar to those described for the tray **400**, detailed descriptions will be omitted, and the differences will be mainly described. All components identical to those of the tray **400** shown in FIGS. **1** to **6** are assigned the same reference symbols in FIG. **8**.

[0097] Referring to FIG. **8**, the adsorption groove **470** may be formed in an adsorption surface **421**. The adsorption groove **470** may extend from the adsorption hole **460**. That is, the adsorption groove **470** may be in the same pressure state as the adsorption maintenance space **430** when a material W is adsorbed onto the adsorption surface **421**.

[0098] The adsorption groove **470** may generate a pressure difference ΔP to expand an adsorption area for adsorbing the material W. Specifically, since the adsorption groove **470** is present, the adsorption area for adsorbing the material W may be further increased from the sum of cross-sectional areas of the adsorption holes **460** to the sum of cross-sectional areas of the adsorption grooves **470**. Accordingly, an upper limit of the pressure difference ΔP that may be formed by a low pressure forming unit **200** is increased, thereby improving an adsorption force of the adsorption surface **421** for the material W. In addition, even when a time for the material W to pass through a process section P becomes longer, a state in which the material W is adsorbed onto the adsorption surface **421** can be maintained.

[0099] A shape of the adsorption groove **470** is not particularly limited. As an example, as shown in FIG. **8**, the adsorption groove **470** may have a shape that connects a plurality of adsorption holes **460** to each other. However, the adsorption groove **470** may be spaced apart from an edge of the support **420**. Accordingly, the adsorption maintenance space **430** may be connected to the outside, thereby preventing an external fluid from being suctioned.

[0100] FIG. **9** is a view illustrating a portion of a tray **400**C according to still another embodiment of the present invention. FIG. **10** shows views illustrating a process of separating a material W from the tray **400**C in sequence through a cross section of the tray **400**C along line III-III′ of FIG. **9**.

[0101] The tray **400**C may include a tray body **410**, a support **420**, an adsorption maintenance space **430**, a flow path entrance **440**, a connection flow path **450**, an adsorption hole **460**, an adsorption groove **470**, and a through-hole **480**. However, the adsorption groove **470** may be omitted. Since the tray body **410**, the support **420**, the adsorption maintenance space **430**, the flow path entrance **440**, the connection flow path **450**, the adsorption hole **460**, and the adsorption groove **470** are identical or similar to those described for the trays **400** and **400**B, detailed descriptions will be omitted, and the differences will be mainly described. All components identical to those of the tray **400** shown in FIGS. **1** to **8** are assigned the same reference symbols in FIGS. **9** and **10**.

[0102] A plurality of lift pins LP for lifting the material W may pass through the through-holes **480**. Referring to FIG. **9**, a plurality of through-holes **480** may be formed. The through-holes **480** may be formed in the support **420**. Referring to FIG. **10**, the through-holes **480** may pass through both the tray body **410** and the support **420**. Accordingly, the lift pin LP may protrude above the support

420 to lift the material W.

[0103] A process in which the material W is lifted by the lift pin LP will now be briefly described. Referring to FIG. **10**A, the lift pin LP may pass through the through-holes **480** of the tray **400**C, which has passed through all of a plurality of process sections P, to be lifted in a Z-axis direction. Referring to FIG. **10**B, the lift pin LP may be continuously lifted to lift the material W. Referring to FIG. **10**A, the lifted material W may be transferred to a subsequent process.

[0104] Referring to FIGS. **9** and **10**, the through-holes **480** may be spaced apart from the adsorption maintenance space **430**. As described above, since the through-hole **480** passes through the tray body **410**, an arrangement relationship with the adsorption maintenance space **430** may be problematic. That is, since the through-holes **480** are positioned apart from the adsorption maintenance space **430**, the airtightness of the adsorption maintenance space **430** can be maintained.

[0105] FIG. **11** is a plan view illustrating a substrate processing apparatus **1**A according to another embodiment of the present invention. FIG. **12** is a diagram illustrating a movement speed v and a pressure difference ΔP according to a position of a material W in the substrate processing apparatus **1**A according to another embodiment of the present invention.

[0106] The substrate processing apparatus **1**A may include a driving unit **100**, a low pressure forming unit **200**, a pressure difference removing unit **300**, and a tray **400**. Since the driving unit **100**, the pressure difference removing unit **300**, and the tray **400** are identical or similar to those described for the substrate processing apparatus **1** described above, detailed descriptions will be omitted, and the differences will be mainly described. All components identical to those of the substrate processing apparatus **1** shown in FIGS. **1** to **10** are assigned the same reference symbols in FIGS. **11** and **12**.

[0107] The low pressure forming unit **200** may include a plurality of low pressure forming units. Accordingly, the adsorption maintenance space **430** may be connected to the low pressure forming units **200** a plurality of times while passing through a plurality of process sections P, thereby repeatedly discharging a fluid from the inside of the adsorption maintenance space **430**. That is, by repeatedly generating a low-pressure state inside the adsorption maintenance space **430**, an adsorption force of the adsorption surface **421** for the material W can be strengthened such that the material W remains adsorbed onto an adsorption surface **421** while the tray **400** passes through the process section P.

[0108] In one embodiment, the low pressure forming unit **200** may include a number of low pressure forming units corresponding to a number of process sections P included in the plurality of process sections P. For example, as shown in FIG. **11**, when the plurality of process sections P include a first process section P**1**, a second process section P**2**, a third process section P**3**, a fourth process section P**4**, and a fifth process section P**5**, the low pressure forming unit **200** may include a first low pressure forming unit **200***a*, a second low pressure forming unit **200***b*, a third low pressure forming unit **200***c*, a fourth low pressure forming unit **200***d*, and a fifth low pressure forming unit **200***e*. However, the present invention is not limited thereto. In another embodiment, the low pressure forming unit **200** may include a number of low pressure forming unit that are smaller than a number of process sections P included in the plurality of process sections P.

[0109] Each of a plurality of low pressure forming units **200** may be disposed at a position before the tray **400** enters one of the plurality of process sections P. The tray **400** may have a movement speed v of 0 for a moment while connected to the low pressure forming unit **200**. That is, since the low pressure forming unit **200** is disposed at a position before the tray **400** enters each of the plurality of process sections P, the tray **400** may move without stopping within the plurality of process sections P so that each process may proceed smoothly.

[0110] For example, as shown in FIG. **11**, the first low pressure forming unit **200***a* may be disposed at a position before the tray **400** enters the first process section P**1**. The second low pressure forming unit **200***b* may be disposed at a position before the tray **400** enters the second process section P**2**. The third low pressure forming unit **200***c* may be disposed at a position before the tray **400** enters the third process section P**3**. The fourth low pressure forming unit **200***d* may be disposed at a position before the tray **400** enters the fourth process section P**4**. The fifth low pressure forming unit **200***e* may be disposed at a position before the tray **400** enters the fifth process section P**5**.

[0111] In another embodiment, when the low pressure forming unit **200** includes a number of low pressure forming units that are smaller than a number of process sections P included in the plurality of process sections P, each of the low pressure forming units **200** may be positioned at a position before the tray **400** enters one of some of the plurality of process sections P. In this case, an arrangement position of the low pressure forming unit **200** may be determined according to the process characteristics of the plurality of process sections P.

[0112] Pressure differences ΔP formed by some or all of the plurality of low pressure forming units **200** may be different. Specifically, the pressure difference ΔP has a value obtained by subtracting an external pressure from a pressure inside the adsorption maintenance space **430**. Referring to FIG. **12**, the pressure difference ΔP may be less than 0. However, when sizes of the pressure differences ΔP are compared in the present specification, absolute values of the pressure differences ΔP are compared. Hereinafter, the same applies in the specification.

[0113] For example, referring to FIGS. **11** and **12**, the first low pressure forming unit **200***a* disposed before the tray **400** enters the first process section P**1** may form a first pressure difference Δ**1** in the adsorption maintenance space **430**. The second low pressure forming unit **200***b* disposed before the tray **400** enters the second process section P**2** may form a second pressure difference **42** in the adsorption maintenance space **430**. The third low pressure forming unit **200***c* disposed before the tray **400** enters the third process section P**3** may form a third pressure difference Δ**3** in the adsorption maintenance space **430**. The fourth low pressure forming unit **200***d* disposed before the tray **400** enters the fourth process section P**4** may form a fourth pressure difference **44** in the adsorption maintenance space **430**. The fifth low pressure forming unit **200***e* disposed before the tray **400** enters the fifth process section P**5** may form a fifth pressure difference **45** in the adsorption maintenance space **430**.

[0114] An example of the more specific characteristics of the process section P will now be described. However, the following description is merely an example for describing the features of the substrate processing apparatus **1**A and is not limiting. In other words, the substrate processing apparatus **1**A is not limited to the following cases and may be applied to all cases in which the plurality of process sections P are continuous.

[0115] As an example, the substrate processing apparatus **1** or **1**A may be used for manufacturing a perovskite solar cell or a tandem solar cell including perovskite. More specifically, the substrate processing apparatus **1** or **1**A can be used for manufacturing a tandem solar cell.

[0116] A tandem solar cell may include a recombination layer, a hole transfer layer, and a perovskite light-absorbing layer which are disposed on a first solar cell.

[0117] The first solar cell may include any one of various solar cells such as a crystalline silicon (Si) solar cell, a polycrystalline silicon solar cell, a copper indium gallium selenide (CIGS)-based solar cell, a perovskite solar cell, a gallium arsenide (GaAs) solar cell, a dye sensitized solar cell, an organic solar cell, and a compound solar cell.

[0118] The recombination layer may be a layer that induces recombination of electrons and holes generated in at least one of the first solar cell and the perovskite light-absorbing layer.

[0119] The hole transfer layer may be a layer that transfers holes formed in the perovskite light-absorbing layer and blocks the movement of electrons.

[0120] The perovskite light-absorbing layer is a layer that absorbs light and may include a perovskite material.

[0121] In addition, the tandem solar cell may further include a protective layer. The protective layer may be disposed between the electron transfer layer and the perovskite light-absorbing layer. The protective layer may facilitate the transfer of holes and may prevent a phenomenon in which generated charges recombine with each other.

[0122] For this purpose, the protective layer may include a material having a carbazole body with excellent hole transfer and collection power and a phosphonic acid group with excellent bonding power with a metal oxide. Specifically, the protective layer may include a self-assembled monolayer (SAM) material. As an example, the protective layer may include a SAM material such as 2-PACz, MeO-2PACz, Br-2PACz, Me4PACz, MeO-4PACz, or 6-PACz.

[0123] As a specific embodiment, the substrate processing apparatus **1** or **1**A may form the protective layer.

[0124] The first process section P**1** may correspond to a plasma treatment process. The first process section P**1** may correspond to a treatment process using atmospheric pressure plasma. In the first process section P**1**, the material W may be treated with plasma before being coated with a SAM material. A movement speed v of the tray required in the first process section P**1** may be a first movement speed v**1**.

[0125] The process of the second process section P**2** may be performed after that of the first process section P**1**. The second process section P**2** may correspond to a rinse process. The process of the second process section P**2** may be performed in a spray manner. The movement speed v of the tray required in the second process section P**2** may be a second movement speed v**2**.

[0126] The process of the third process section P**3** may be performed after that of the second process section P**2**. The third process section P**3** may correspond to a first drying process. The third process section P**3** may correspond to an air-blowing drying process. The movement speed v of the tray required in the third process section P**3** may be a third movement speed v**3**.

[0127] The process of the fourth process section P**4** may be performed after that of the third process section P**3**. The fourth process section P**4** may correspond to a coating process. The fourth process section P**4** may correspond to a spray coating process. In the fourth process section P**4**, a SAM material may be sprayed onto the material W. In the fourth process section P**4**, the material W may be coated with the SAM material. As an example, a material sprayed in the fourth process section P**4** may include a SAM material such as 2-PACz, MeO-2PACz, Br-2PACz, Me4PACz, MeO-4PACz, or 6-PACz. The movement speed v of the tray required in the fourth process section P**4** may be a fourth movement speed v**4**.

[0128] The process of the fifth process section P**5** may be performed after that of the fourth process section P**4**. The fifth process section P**5** may correspond to a second drying process. The fifth process section P**5** may correspond to an air-blowing drying process. In the fifth process section P**5**, the SAM material sprayed onto the material W may be dried. The movement speed v of the tray required in the fifth process section P**5** may be a fifth movement speed v**5**.

[0129] Widths of the first to fifth process sections P**1** to P**5** are assumed to all be the same. Since the first movement speed v**1** required in the first process section P**1** is faster than the second to fifth movement speeds v**2**, v**3**, v**4**, and v**5** required in the other process sections, a time for the tray **400** to stay in the first process section P**1** may be shorter than that in the other process sections. Taking this into account, the first pressure difference Δ**1** formed by the first low pressure forming unit **200***a* disposed before the tray **400** enters the first process section P**1** may be smaller than the second to fifth pressure differences **42**, **43**, **44**, and **45** formed by the low pressure forming units **200** disposed before the tray **400** enters the other process sections.

[0130] The second movement speed v**2** required in the second process section P**2** may be slower than the first movement speed v**1** required in the first process section P**1**. Thus, a time for the tray **400** to stay in the second process section P**2** may be longer than that in the first process section P**1**. Taking this into account, the second pressure difference **42** formed by the second low pressure forming unit **200***b* disposed before the tray **400** enters the second process section P**2** may be greater than the first pressure difference Δ**1** formed by the first low pressure forming unit **200***a* disposed before the tray **400** enters the first process section P**1**.

[0131] The third movement speed v**3** required in the third process section P**3** may be slower than the second movement speed v**2** required in the second process section P**2**. Thus, a time for the tray **400** to stay in the third process section P**3** may be longer than that in the second process section P**2**. Taking this into account, the third pressure difference Δ**3** formed by the third low pressure forming unit **200***c* disposed before the tray **400** enters the third process section P**3** may be greater than the second pressure difference Δ**2** formed by the second low pressure forming unit **200***b* disposed before the tray **400** enters the second process section P**2**.
[0132] The fourth movement speed v**4** required in the fourth process section P**4** may be faster than the third movement speed v**3** required in the third process section P**3**. Thus, a time for the tray **400** to stay in the fourth process section P**4** may be shorter than that in the third process section P**3**. Taking this into account, the fourth pressure difference Δ**4** formed by the fourth low pressure forming unit **200***d* positioned before the tray **400** enters the fourth process section P**4** may be smaller than the third pressure difference Δ**3** formed by the third low pressure forming unit **200***c* disposed before the tray **400** enters the third process section P**3**.
[0133] In one embodiment, a time for the tray **400** to stay in the fourth process section P**4** may be shorter than or equal to the time for the tray **400** to stay in the second process section P**2**. For this purpose, the fourth movement speed v**4** may be faster than or equal to the second movement speed v**2**. In addition, the fourth pressure difference **44** may be smaller than or equal to the second pressure difference Δ**2**. In one embodiment, the time for the tray **400** to stay in the fourth process section P**4** may be equal to the time for the tray **400** to stay in the second process section P**2** so that the fourth movement speed v**4** may be equal to the second movement speed v**2**, and the fourth pressure difference Δ**4** may be equal to the second pressure difference Δ**2**.
[0134] The fifth movement speed v**5** required in the fifth process section P**5** may be slower than the fourth movement speed v**4** required in the fourth process section P**4**. Thus, a time for the tray **400** to stay in the fifth process section P**5** may be longer than that in the fourth process section P**4**. Taking this into account, the fifth pressure difference **45** formed by the fifth low pressure forming unit **200***e* disposed before the tray **400** enters the fifth process section P**5** may be greater than the fourth pressure difference Δ**4** formed by the fourth low pressure forming unit **200***d* disposed before the tray **400** enters the fourth process section P**4**.
[0135] In one embodiment, the time for the tray **400** to stay in the fifth process section P**5** may be longer than or equal to the time for the tray **400** to stay in the third process section P**3**. For example, in order to effectively dry the SAM material deposited on the material W in the fourth process section P**4**, a time for the tray **400** to stay in the fifth process section P**5** may be longer than or equal to a time for the tray **400** to stay in the third process section P**3**. For this purpose, the fifth movement speed v**5** may be slower than or equal to the third movement speed v**3**. In addition, the fifth pressure difference **45** may be greater than or equal to the third pressure difference Δ**3**. In one embodiment, the time for the tray **400** to stay in the fifth process section P**5** may be equal to the time for the tray **400** to stay in the third process section P**3** so that the fifth movement speed v**5** may be equal to the third movement speed v**3**, and the fifth pressure difference **45** may be equal to the third pressure difference Δ**3**.
[0136] As can be seen from the specific example above, by making the pressure difference ΔP formed by the low pressure forming unit **200** disposed before the tray enters each process section P different for each process section P, an adsorption state of the material W passing through each process section P may be adjusted according to the characteristics of each process section P. Accordingly, a preset material may be applied and deposited on the material W through an in-line process, thereby enabling efficient process operation and contributing to an improvement in product productivity.
[0137] Since a driving unit provided in a substrate processing apparatus according to one embodiment of the present invention can control a speed for each process section, there is no need to secure a transfer distance for speed compensation for each process, a limited number of trays can

be used repeatedly, and thereby a size of equipment can be reduced.

[0138] In a substrate processing apparatus according to one embodiment of the present invention, by making an area of an adsorption surface smaller than one surface of a material, unnecessary contamination of the material passing through a coating process can be prevented, and an adsorption force of the adsorption surface for the material can be simultaneously maintained.

[0139] In a substrate processing apparatus according to one embodiment of the present invention, an adsorption maintenance space may be formed to delay (buffer) a time for an adsorption force of an adsorption surface for a material to decrease, thereby maintaining a state in which the material is adsorbed onto the adsorption surface while a tray passes through a process section.

[0140] In a substrate processing apparatus according to one embodiment of the present invention, a pressure difference, which is formed by a low pressure forming unit, which is disposed before a tray enters each process section, is set differently for each process section, and thereby an adsorption state of a material passing through each process section is adjusted according to the characteristics of each process section. Therefore, it is possible to enable efficient process operation and contribute to an improvement in product productivity.

[0141] In a substrate processing apparatus according to one embodiment of the present invention, a preset material, for example, a SAM material, can be applied and deposited on a material through an in-line process, thereby improving process efficiency.

[0142] The effects of the present invention are not limited to the above-described effects, and other effects which are not described will be clearly understood by those skilled in the art from the following detailed description and the accompanying drawings.

[0143] The present invention has been described above with reference to embodiments shown in the drawings, but these are only examples. Those of ordinary skill in the art may fully understand that various modifications and other equivalent embodiments are possible from the embodiments. Therefore, the true technical protection scope of the present invention should be determined based on the appended claims.

[0144] Specific technical content described in the embodiments relates to embodiments and does not limit the technical scope of the embodiments. In order to concisely and clearly describe the invention, descriptions of conventional general techniques and configurations may be omitted. In addition, the connection or connection members of lines between the components shown in the drawings are illustrative of functional connections and/or physical or circuit connections and may be represented as a variety of functional connections, physical connections, or circuit connections that can be replaced or added in an actual device. In addition, when there is no specific mention such as “essential” or “importantly,” a component may not be an essential component for the application of the present invention.

[0145] In the description of the invention and in the claims, “the” or similar referents may refer to both the singular and the plural unless otherwise specified. In addition, when a range is described in the embodiment, it includes the invention to which individual values within the range are applied (unless there is a description to the contrary), and each individual value constituting the range is described in the description of the invention. In addition, the operations constituting the method according to the embodiment may be performed in any appropriate order unless the order is explicitly stated or there is a description to the contrary. The embodiments are not necessarily limited by the described order of the operations. The use of all examples or illustrative terms (e.g., “and the like”) in the embodiments is merely for the purpose of describing the embodiments in detail, and unless limited by the claims, the scope of the embodiments is not limited by the above examples or exemplary terms. In addition, those skilled in the art will appreciate that various modifications, combinations, and changes may be made in accordance with design conditions and factors within the scope of the appended claims or their equivalents.

Claims

1. A substrate processing apparatus comprising: a tray having an adsorption maintenance space formed therein; a driving unit configured to allow the tray to successively pass through a plurality of process sections; a low pressure forming unit positioned at one side of the driving unit at a position before the tray enters the plurality of process sections and configured to discharge a fluid from the adsorption maintenance space to form a pressure difference between the adsorption maintenance space and an outside; and a pressure difference removing unit disposed at one side of the driving unit at a position at which all of the plurality of process sections end and configured to inject a fluid into the adsorption maintenance space, wherein the tray adsorbs a material using the pressure difference.
2. The substrate processing apparatus as claimed in claim 1, wherein the material moves through each of the plurality of process sections for a movement time set for each of the plurality of process sections, and the movement times are all different or some are equal among the plurality of process sections.
3. The substrate processing apparatus as claimed in claim 2, wherein a movement speed at which the driving unit moves the tray is different for each of the plurality of process sections.
4. The substrate processing apparatus as claimed in claim 1, wherein the tray further includes a support on which the material is placed, the support includes an adsorption surface which is in in contact with one surface of the material to adsorb the material, and an area of the adsorption surface is smaller than that of the one surface of the material with which the adsorption surface is in contact.
5. The substrate processing apparatus as claimed in claim 4, wherein the tray further includes: at least one adsorption hole formed in the adsorption surface and connected to the adsorption maintenance space; a flow path entrance that closes when separated from the low pressure forming unit and the pressure difference removing unit; and a connection flow path configured to connect the adsorption maintenance space and the flow path entrance.
6. The substrate processing apparatus as claimed in claim 5, wherein the tray further includes an adsorption groove formed in the adsorption surface and extending from the adsorption hole.
7. The substrate processing apparatus as claimed in claim 5, wherein the support further includes an adsorption auxiliary member, and the adsorption auxiliary member includes a second adsorption hole which is formed in an area corresponding to the adsorption hole and communicates with the adsorption hole.
8. The substrate processing apparatus as claimed in claim 1, wherein the tray further includes a plurality of through-holes through which a plurality of lift pins configured to lift the material pass, and the through-holes are spaced apart from the adsorption maintenance space.
9. The substrate processing apparatus as claimed in claim 1, wherein the low pressure forming unit includes a plurality of low pressure forming units, and each of the plurality of low pressure forming units is positioned at a position before the tray enters one of the plurality of process sections.
10. The substrate processing apparatus as claimed in claim 9, wherein the pressure difference formed by some or all of the plurality of low-pressure forming units are different.
11. The substrate processing apparatus as claimed in claim 2, wherein the plurality of process sections include: a first process section in which a plasma treatment process is performed on the material; a second process section in which a rinse process is performed on the material; a third process section in which a first drying process is performed on the material; a fourth process section in which a coating process is performed on the material; and a fifth process section in which a second drying process is performed on the material, wherein the coating process includes a process of coating the material with a self-assembled monolayer (SAM) material.