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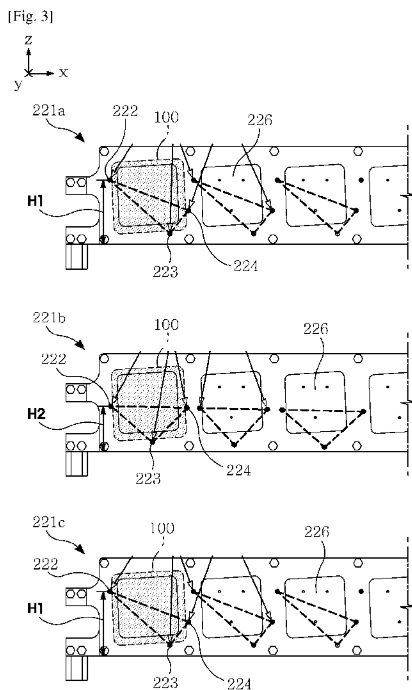
# (54) Title: BOAT DEVICE




**(57) Abstract:** The present invention discloses a boat device, comprising: a plate portion including mutually adjacent first and second plates, where a wafer is attached and detached in an empty gap between each plate; and a pin provided at each plate to support an outside of the wafer; wherein the pin is provided with at least three pins including a first pin, a second pin and a third pin relative to one wafer.

WO 2019/045204 A1

[Continued on next page]

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# Description

# Title of Invention: BOAT DEVICE

## Technical Field

[1] The teachings in accordance with exemplary and non-limiting embodiments of this invention relate generally to a boat device configured to support a wafer inside a chamber in solar cell manufacturing equipment.

[2]

## Background Art

[3] Solar cell manufacturing equipment is such that a plurality of wafers is inputted into a chamber, and P-N junction is formed on a wafer through plasma process such as PECVD. A boat device supports the wafer inside the chamber.

[4] Electricity may be applied to the wafer in order to form plasma of ICP (Inductively Coupled Plasma) etching method or CCP (Capacitively Coupled Plasma) etching method, or to electrostatically chuck the wafer to the boat device. Meantime, there is a need to stably support the plurality of wafers in order to allow the plurality of wafers to maintain a predetermined position inside the reacting chamber.

[5] The boat device may include a metal support structure that stably supports the wafers inside the chamber and applies the electricity to the wafers. At this time, an arc may be generated from the metal support structure provided at the boat device to degrade plasma uniformity, or to cause a processing point unwanted on the wafers. Thus, an erroneous design of metal support structure on the boat device may trigger a processing defect in the solar cell wafer.

[6]

## Disclosure of Invention

## Technical Problem

[7] The present invention is to provide a boat device configured to restrict generation of arc caused by metal support structure of boat device during plasma formation inside a chamber in solar cell manufacturing equipment.

[8]

## Solution to Problem

[9] In one general aspect of the present invention, there is provided a boat device, the boat device comprising:

[10] a plate portion including mutually adjacent first and second plates, where a wafer is attached and detached in a gap between each plate; and

[11] a pin provided at each plate to support an outside of the wafer; wherein

[12] the pin is provided with at least three pins including a first pin, a second pin and a

third pin relative to one wafer.

[13] Preferably, but not necessarily, the first pin, the second pin and the third pin mounted on each of the mutually adjacent plates may be so arranged as not to face each other, and each pin may be zigzaggedly arranged along a first direction, which is a direction where a plurality of plates is stacked.

[14]

## Advantageous Effects of Invention

[15] In consideration of phenomenon of plasmas being concentrated on a distance-close area where plasmas are generated, a metal portion protruded to a plate portion may be degraded in thickness uniformity and quality of evaporation film. Furthermore, when a current for plasma formation is concentrated on a pin corresponding to a support structure of a wafer, this may be a cause for generating an arc.

[16] The present invention is configured in such a manner that a pin, which is a support structure of wafer inside a boat device is made to be arranged in a zigzagged way to make a distance between support structures to be farther than a distance between electrodes, whereby the plasma concentration phenomenon and generation of arc can be restricted. Thus, the uniformity of evaporation film and quality can be improved, and reliability of device can be enhanced due to restriction of arcing during process.

[17]

## Brief Description of Drawings

[18] FIG. 1 is a cross-sectional view illustrating a solar cell manufacturing equipment installed with a boat device.

[19] FIG. 2 is a perspective view illustrating a boat device according to the present invention.

[20] FIG. 3 is a lateral view illustrating mutually adjacent plates being exploded according to an exemplary embodiment of the present invention.

[21] FIG. 4 is a partial plane view illustrating mutually adjacent plates according to an exemplary embodiment of the present invention.

[22]

## Best Mode for Carrying out the Invention

[23] Hereinafter, some of exemplary embodiments of the present invention will be described in detail with reference to the accompany drawings. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity. Accordingly, the meaning of specific terms or words used in the specification and claims should not be limited to the literal or commonly employed sense, but should be construed or may be different in accordance with the intention of a user or an operator and customary usages. Therefore, the definition of the specific terms or words should be based on the

contents across the specification.

[24] FIG. 1 is a cross-sectional view illustrating solar cell manufacturing equipment installed with a boat device (220).

[25] Referring to FIG.1, the solar cell manufacturing equipment may be provided with a nozzle portion (214) inputting reaction gas (reactant) or inert gas into a chamber (210). Various types of reaction gases and inert gases are inputted into the chamber (210) that maintains a predetermined reaction temperature or pressure for each process. A wafer (100) may be deposited with a doping layer, a passivation layer, a capping layer and a reflection prevention layer inside the chamber (210) in response to types of reaction gases and inert gases. Because processing of a plurality of wafers at one time is advantageous for improvement of productivity, a plurality of wafers (100) may be inputted into the chamber at one time by a boat device (220). The boat device (220) loaded with the wafers (100) may be inputted into the chamber (210) through a chamber inlet (211), and a heater (25) may be installed at an inside or an outside of the chamber (210) in order to supply heat to the chamber (210).

[26] The plasma process as well as heat treatment process may be performed inside the chamber (210). For example, the nozzle portion (214) can inject oxidizers and reaction gases into the chamber (210) that maintains a predetermined temperature in order to perform a PDA (Post-Deposition Annealing) process. The heat treatment process can be performed by maintaining a temperature inside the chamber (210) at 200°C ~ 500°C under an oxidizer atmosphere inside the chamber (210).

[27] FIG. 2 is a perspective view illustrating a boat device (220) according to the present invention.

[28] Referring to FIGS. 1 and 2, a plate portion (221) may be several mutually adjacent plates, and may include a first plate (221a), a second plate (221b), and a second plate (221b). The wafer (100) may be attached or detached at an empty gap between each plate. The wafer (100) may be mounted in a plural number between the plate and the plate, and several plates may be mounted depending on a lengthwise direction of one plate.

[29] The plate portion (221) may move into the chamber (210) or outside of the chamber (210) while being loaded with a plurality of wafers (100). While the boat device (220) is extracted to outside through the chamber inlet (211), the process-finished wafer (100) may be unloaded or a new wafer (100) may be loaded.

[30] The boat device (220) may be inputted into the chamber (210) while being loaded with a plurality of wafers (100). When the plasmas are formed inside the chamber (210), the plurality of wafers (100) loaded on the boat device (220) may be processed at one time.

[31] Here, a crosswise direction of plate portion (221) stacked with the first plate (221a)

and the second plate (221b) is defined as a first direction, and a lengthwise direction of the plate portion (221) stacked with the first plate (221a) or the second plate (221b) is defined as a second direction.

[32] A plurality of wafers (100) may be loaded along the second direction, which is a lengthwise direction of each plate, and a plurality of wafers (100) may be loaded along the second direction corresponding to the number of plates. The plurality of wafers (100) may be inputted into the chamber (210) at one time and processed at one time.

[33] Each plate may include a plate pocket (226) that is partially punched of each plate, and an exposed wafer (100) may face the plasma or the reaction gas and processed through the plate pocket (226).

[34] FIG. 3 is a lateral view illustrating mutually adjacent plates being exploded according to an exemplary embodiment of the present invention, and FIG. 4 is a partial plane view illustrating mutually adjacent plates according to an exemplary embodiment of the present invention.

[35] Referring to FIGS. 1 to 4, each plate may include a plurality of pins. The pin may support an outside of the wafer (100).

[36] As an exemplary embodiment, one wafer (100) may be supported by a first pin (222), a second pin (223) and a third pin (224). When the wafer (100) is supported by at least three pins, a vertex of an imaginary triangle connecting each pin may form three support points, and the wafer (100) can be supported using a minimum pin by a triangle support structure. As the number of pins contacting the wafer (100) are reduced, a processing defect of wafer (100) caused by the pin can be restricted.

[37] The first pin (222) may be contacted to one side or left side of the wafer (100), the third pin (224) may be contacted to the other side or right side, and the second pin (223) may be contacted to a bottom side of the water (100). The second pin (223) may support a load of the wafer (100), and the first pin (222) and the third pin (224) may perform a function of maintaining a position by preventing rotation of wafer (100) or by restricting a horizontal (left/right) movement of the wafer (100). The positions of the illustrated first pin (222), the second pin (223) and the third pin (224) may be mutually changeable because the positions are merely exemplary.

[38] Meanwhile, at least two pins out of the first pin (222), the second pin (223) and the third pin (224) may be connected to an electrode of plate. If the first pin (222) and the second pin (223) are connected to an electrode of plate, the third pin (224) may be simply a support pin or a contact pin instead of applying a power to the wafer (100).

[39] Meanwhile the first pin (222) may be a pin connected to an electrode of plate, and the second pin (223) may be a ground pin connected to the ground. The power applied to the wafer (100) may be to induce the plasma applied to the wafer (100), or to provide an electrostatic force to the wafer (100).

[40] In order to realize the solar cell manufacturing equipment, the chamber (210) may be a furnace to perform a heat treatment. When the chamber (210) is a horizontal furnace lengthily and horizontally extended as shown in FIG. 1, the chamber (210) may be used as a holder for supplying plasma power and to supporting the wafer (100) using a graphite material pin which is an electrically conductive material in order to apply a plasma formation power to the wafer (100).

[41] Meantime, when a plasma power applied to the wafer (100) is asymmetrically supplied, there may be generated a warpage to a particular area of the plasma power, whereby defects of thickness of thin film being locally increased may be generated and a problem of difficulty in controlling a thin even uniform film thickness may be generated during mass production.

[42] The present invention has an advantageous effect in that plasma density can be uniformly formed inside the chamber (210) to enhance thin film uniformity, and to promote quality improvement and cost reduction by employing a structure capable of evenly maintaining a gap between plates inside the boat device (220) without using additional parts.

[43] In a boat device (220) functioning as an electrode to feed the wafer (100) inputting/outputting a plurality of wafers (100) inside the chamber (210) at one time using a batch method, or to induce plasmas to wafers (100), a pin structure contacted to an outside of the wafer (100) may be more protruded than the plate.

[44] As an exemplary embodiment, when a plate itself is an electrode or an electrode lower than a pin is installed on the boat device (220), the pin structure supporting the wafer (100) may be more protruded than the plate or the electrode. Thus, when a pin corresponding to a support structure of the wafer (100) is more protruded than a plate or an electrode in the boat device (220), a distance between pins may be relatively closer than a distance between electrodes.

[45] This structure may degrade the thickness uniformity and quality of deposit film when thin film is deposited to the wafer (100) in consideration of a phenomenon where plasmas are concentrated to a shorter-distanced area when the plasmas are generated. Furthermore, because a current for forming the plasmas is concentrated to a pin corresponding to the support structure of the wafer (100), this may be a cause to generate an arc (arcing).

[46] Hence, the present invention can restrict the plasma concentration phenomenon and generation of arc (arcing) by so arranging the support structure of wafer (100) inside the boat device (220) as to make a distance between support structures more distanced than a distance between electrodes.

[47] The boat device (220) may include a plate functioning as an electrode, whereby a pin, which is a support structure fixing the wafer (100) to the plate, can be zigzaggedly

arranged. The pin may function to fix the wafer (100) to an electrode surface of plate, or to transmit a power applied to the plate to the wafer (100).

[48] A contact point of wafer (100) may be limited to three points where the first pin (222), the second pin (223) and the third pin (224) contact the wafer (100) to achieve a stable 3-point support structure, and the first pin (222), the second pin (223) and the third pin (224) respectively mounted to mutually adjacent plates are so arranged as not to face each other, where each pin may be zigzaggedly arranged along the first direction which is a direction where a plurality of plates is stacked.

[49] Referring to FIG. 3, the plurality of pins supporting the wafer (100) may be provided at least in the number of three (3) relative to one wafer (100). The first pin (222), the second pin (223) and the third pin (224) may be arranged on the plate in order to form an imaginary triangle having, as a vertex, the contact point contacted to an outside of the wafer(100).

[50] A plate-partially cut plate pocket (226) may be formed among the first pin (222), the second pin (223) and the third pin (224), and the plate pocket (226) may be a flow path of plasma or reaction gas.

[51] The first pin (222), the second pin (223) and the third pin (224) supporting the wafer (100) loaded on the first plate (221a) are preferably not to face the first pin (222), the second pin (223) and the third pin (224) supporting the wafer (100) stacked on the second plate (221b) adjacent to the first plate (221a).

[52] An imaginary triangle connecting the first pin (222), the second pin (223) and the third pin (224) supporting the wafer (100) stacked on the first plate (221a) is preferably not to match an imaginary triangle connecting the first pin (222), the second pin (223) and the third pin (224) supporting the wafer (100) stacked on the second plate (221b) adjacent to the first plate (221a).

[53] Referring to FIG. 3, it is preferable that heights from a floor surface of the plate portion (221) to the first pin (222) be mutually different to the mutually adjacent first plate (221a) and the second plate (221b).

[54] It is preferable that a first height (H1), which is a height measured from a floor surface of the plate portion (221) relative to the first pin (222) mounted on the first plate (221a), be lower than a second height (H2), which is a height measured from a floor surface of the plate portion (221) relative to the first pin (222) mounted on the second plate (221b) adjacently arranged with the first plate portion (221a).

[55] It does not matter whether a height of the first pin (222) mounted on the third plate (221c) adjacent to the second plate (221b) is same as the height (H1) of the first pin (222) mounted on the first plate (221a) not adjacently arranged with the third plate (221c).

[56] Referring to FIG. 4, when the boat device (220) is viewed from the above, it is

preferable that the first pin (222) respectively arranged on the mutually adjacent first plate (221a) and the second plate (221b) be arranged at mutually different positions in response to the first direction on which the first plate (221a) and the second plate (221b) are arranged.

[57] It is preferable that a first distance (L1), which is a distance from a distal end of one side of the boat device (220) relative to the first pin (222) mounted on the first plate (221a) be longer than a second distance (L2), which is a distance measured from a distal end of one side of the boat device (220) relative to the first pin (222) mounted on the second plate (221b) adjacently arranged with the first plate (221a).

[58] It does not matter whether a distance of a distal end of the boat device of the first pin (222) mounted on the third plate (221c) adjacent to the second plate (221b) is same as the distance (L1) of a distal end of the boat device of the first pin (222) mounted on the first plate (221a) not adjacently arranged with the third plate (221c).

[59] Each pin may be formed with a lug (250) protruded from the plate.

[60] Each pin may be formed with a slope (251) to slantly contact the wafer (100) or to contact a lateral surface of the wafer (100). The slop (251) may correspond to a slope formed at a lateral surface of the lug (250).

[61] An adhesion portion (252) contacting the plate on at least a part of the wafer (100) pressed by each pin may be provided at the plate. A cap portion (254) formed by allowing a part of the plate to be cut may be provided to allow a part of the wafer (100) to be tightly adhered to the plate through the adhesion portion (252). Each plate may be formed with the adhesion portion (252) and the cap portion (254). Here, the cap portion (254) may be where the wafer (100) and the plate are non-contacted, and the adhesion portion (252) may be where the wafer (100) is tightly adhered to the plate.

[62] A power may be applied to the wafer (100) through at least one of the lug (250) formed at each pin, the slope (251) formed at each pin and the adhesion portion (252) formed at each plate. The power applied to the wafer (100) may serve to provide plasma formation or electrostatic power.

[63]

## Sequence Listing Free Text

[64] 100...wafer 205...heater

[65] 210...chamber 211...chamber inlet

[66] 214...nozzle portion 220...boat device

[67] 221...plate portion 221a...first plate

[68] 221b...second plate 221c...third plate

[69] 222...first pin 223...second pin

[70] 224...third pin 226...plate pocket

[71] 250...lug 251...slope

[72] 252...adhesion portion 254...cap portion

# Claims

[Claim 1] A boat device, the boat device comprising:
a plate portion including mutually adjacent first and second plates, where a wafer is attached and detached in a gap between each plate; and
a pin provided at each plate to support an outside of the wafer;
wherein the pin is provided with at least three pins including a first pin, a second pin and a third pin relative to one wafer.

[Claim 2] The boat device of claim 1, wherein the plate portion moves inside or outside of the chamber in a state of the plurality of wafers being stacked,
wherein, when a crosswise direction of the plate portion stacked with the first plate and the second plate are stacked is defined as a first direction, and a lengthwise direction of the plate portion where the first plate and the second plate are extended is defined as a second direction, a plurality of wafers is stacked along the second direction which is a lengthwise direction of each plate, and a plurality of wafers is stacked along the second direction corresponding to the number of plates, and the plurality of wafers is inputted into a chamber at one time and processed at one time while being stacked on the plate portion.

[Claim 3] The boat device of claim 1, wherein the first pin contacts one side or a left side of the wafer, the third pin contacts the other side or the right side of the wafer, and the second pin contacts a bottom side of the wafer,
wherein the position is maintained by allowing the second pin to support a load of the wafer, and by allowing the first and third pins to prevent rotation of the wafer or to restrict the horizontal (left/right) movement.

[Claim 4] The boat device of claim 1, wherein at least two pins out of the first pin, the second pin and the third pin are connected to each electrode of the plate, and the pin includes a graphite material as an electrically conductive material.

[Claim 5] The boat device of claim 1, wherein the first pin, the second pin and the third pin respectively mounted on each adjacent plate are so arranged as not to face each other, and each pin is zigzaggedly arranged along the first direction, which is a direction stacked with the plurality of plates.

[Claim 6] The boat device of claim 1, wherein the first pin, the second pin and the

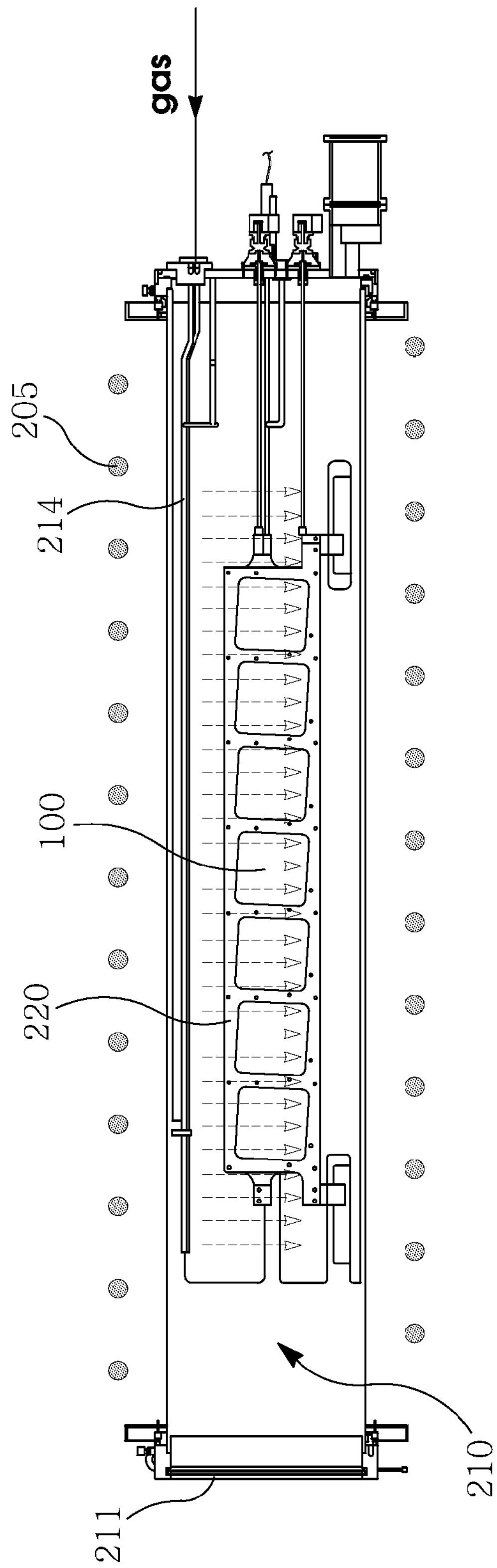
third pin are arranged at each plate in order to form an imaginary triangle having, as a vertex, a contact point contacting an outside of the wafer, and each plate partially cut plate pocket is formed among the first, second and third pins,
wherein the plate pocket becomes a plasma flow path or a reaction gas flow path.

[Claim 7] The boat device of claim 1, wherein the first pin, the second pin and the third pin supporting the wafer stacked on a first plate are so arranged as not to face the first pin, the second pin and the third pin supporting the wafer stacked on a second plate adjacent to the first plate, and an imaginary triangle connecting the first pin, the second pin and the third pin supporting the wafer stacked with the first plate does not match to an imaginary triangle connecting the first pin, the second pin and the third pin supporting the wafer stacked with a second plate adjacent to the first plate.

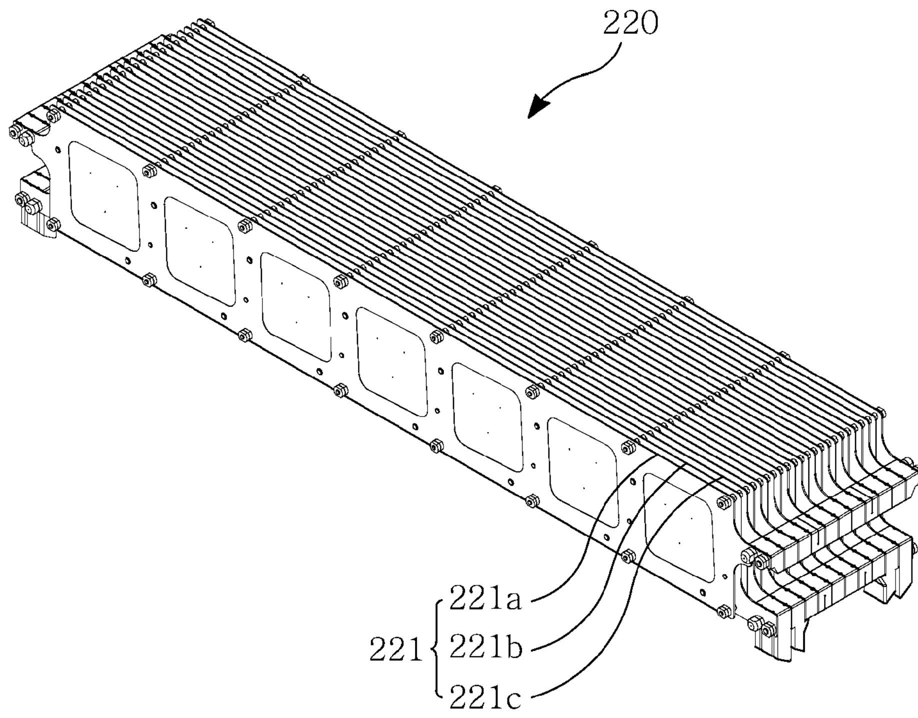
[Claim 8] The boat device of claim 1, wherein heights from a floor surface of the plate portion to the first pin are mutually different to the mutually adjacent first plate and second plate.

[Claim 9] The boat device of claim 1, wherein the first pin respectively arranged at the mutually adjacent first plate and second plate is mutually different positions along the first direction arranged with the first plate and the second plate.

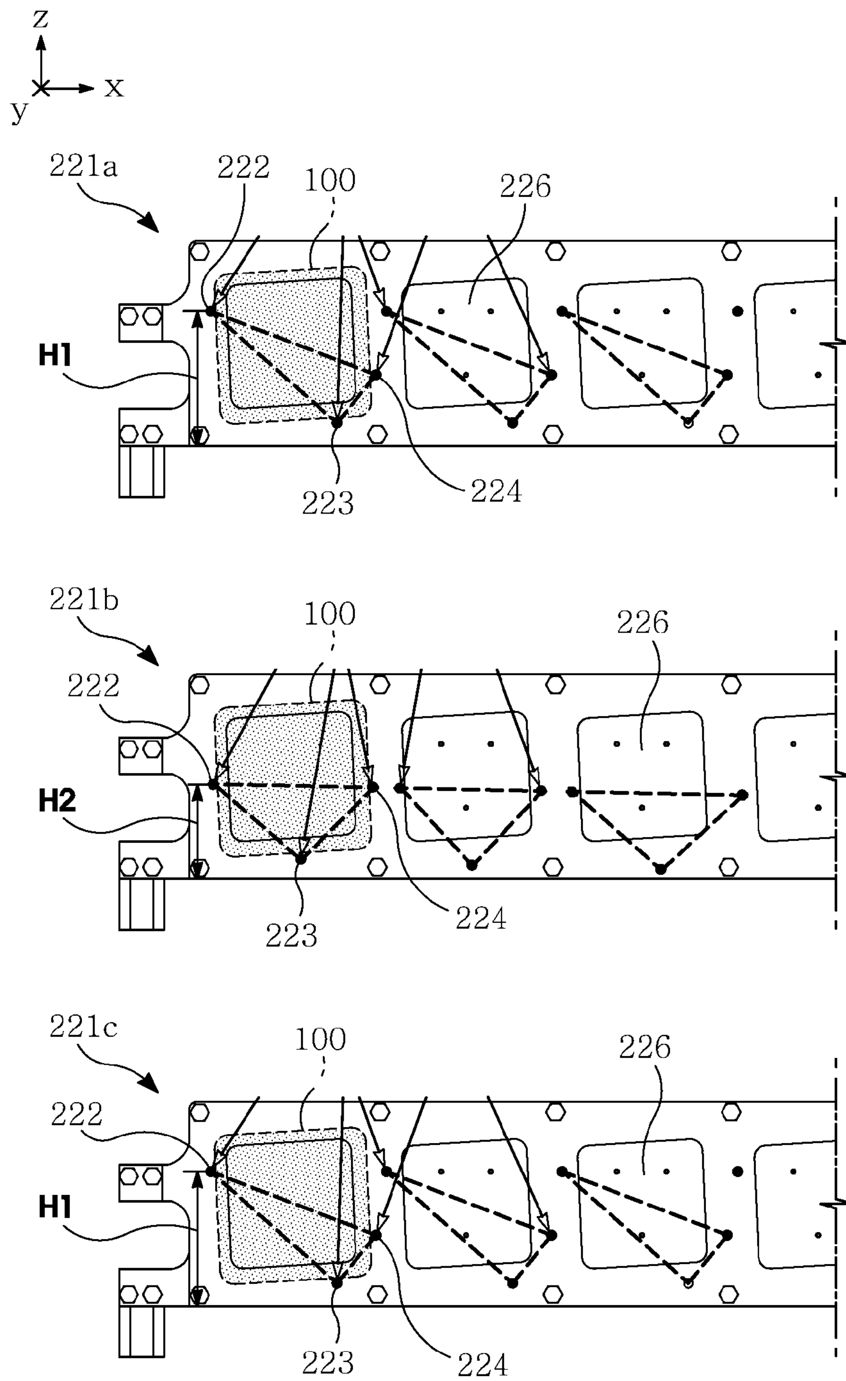
[Fig. 1]



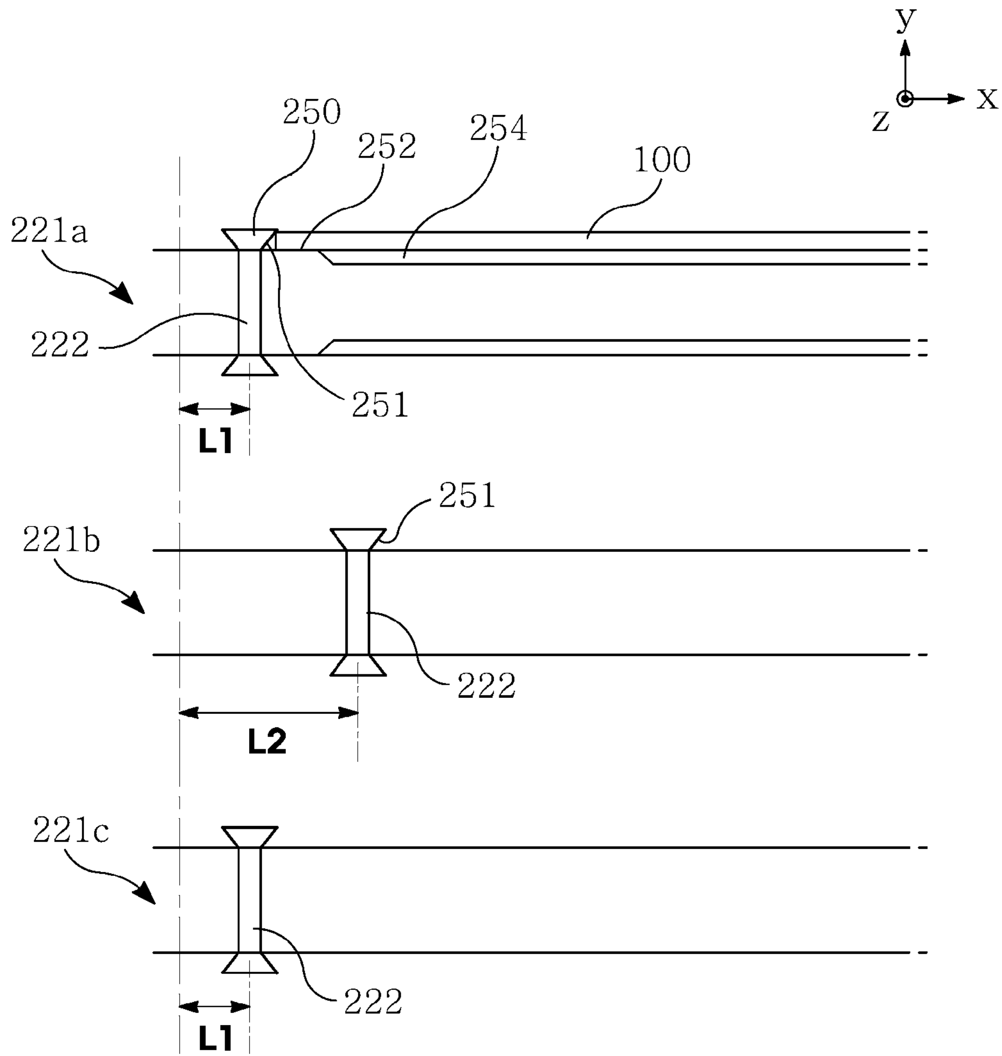
[Fig. 2]



[Fig. 3]



[Fig. 4]



**INTERNATIONAL SEARCH REPORT**

International application No.
**PCT/KR2018/001323**

**A. CLASSIFICATION OF SUBJECT MATTER**

**H01L 21/673(2006.01)i, H01L 31/18(2006.01)i**

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 21/673; H01L 21/3065; H01L 21/683; C23C 16/458; H01L 31/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords:wafer boat, plate, pin, triangle and zigzag

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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☐ Further documents are listed in the continuation of Box C.   ☒ See patent family annex.

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| 30 May 2018 (30.05.2018) | **30 May 2018 (30.05.2018)** |


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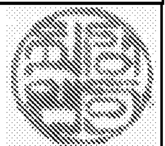

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