

Support device for a plurality of wafers for a vertical oven

FIELD OF THE INVENTION

5 The present invention concerns a support device for a plurality of wafers.

BACKGROUND OF THE INVENTION

A known prior art support device for a plurality of wafers, shown in Figures 1A and 1B, is a support device for a plurality of wafers, the support device 10 being adapted to be loaded into a heat treatment oven, the support device 10 having a central axis X'-X, the support device 10 including:

- three uprights 30, 31 and 32 extending substantially parallel to the central axis X'-X,
- a plurality of series of support members 35 spaced along the central axis X'-X, each series of support members 35 comprising three support members 40, 41 and 42 adapted to support one wafer W of the plurality of wafers and extending in different essentially longitudinal directions transverse to the central axis X'-X, each support member 40, 41 and 42 being mounted directly on a separate upright.

20 Accordingly, a heat treatment step consists in positioning a support device 10 containing a plurality of wafers W in a vertical heat treatment oven (not shown). Each series of support members 35 of the support device 10 includes three support members 40, 41 and 42, the function of which is to hold a wafer W in a horizontal position. Figure 1B shows the positioning of a
25 wafer W relative to the support members 40, 41 and 42. The support members are mounted directly on separate uprights 30, 31 and 32 and the disposition of said support members 40, 41 and 42 is adapted to ensure that a wafer W is held in a stable equilibrium position. Inside the vertical heat treatment oven, heating elements are disposed around a quartz tube into
30 which the support device 10 is inserted. The wafers disposed horizontally in the support device are heated radially by said heating elements. However, the support members 41 and 42 block some of the radiant flux during a heat

treatment step and a locally heterogeneous temperature field is observed over the volume of the wafer at the level of the support members 41 and 42, as shown in Figure 2 (the shaded area symbolizing the flow of heat in the vicinity of the support member 41).

5 If the requirements in terms of homogenous heat treatment are imperatives, such a temperature gradient is not acceptable.

Moreover, a homogeneous temperature of the wafers during a heat treatment step is required when depositing or forming thin layers of materials having a highly uniform thickness.

10 **BRIEF DESCRIPTION OF THE INVENTION**

The present invention aims to remedy the aforementioned disadvantage and concerns a support device for a plurality of wafers, the support device being adapted to be loaded into a heat treatment oven, the support device having a central axis, the support device including:

- 15 - three uprights extending substantially parallel to the central axis,
 - a plurality of series of support members spaced along the central axis, each series of support members comprising three support members adapted to support one wafer of the plurality of wafers and extending in different essentially longitudinal directions transverse to the central axis, each support
 - 20 member being mounted directly on a separate upright,
- said support device being remarkable in that the directions of the three support members of each series of support members are concurrent at a point on the central axis.

By central axis is meant the vertical axis of the support device when it

25 is being used in a vertical heat treatment oven. A wafer intended to be supported by a series of support members has the central axis passing through its centre when said wafer is positioned on said series of support members.

Accordingly, when the support device supports a plurality of wafers

30 and is being used in a vertical oven, the directions concurrent at a point on the central axis of the three support members of each series of support

members enable the radial radiant flux to propagate uniformly without blocking any of the flux.

In one embodiment, the support members of each series of support members are adapted to form an essentially point contact with the
5 corresponding wafer.

Accordingly, holding the wafers so that there is an essentially point contact with the wafer makes it possible to minimize the area of contact between the wafers and the support members.

Moreover, minimizing the area of contact between the wafers and the
10 support members makes it possible to improve the radiant flux during a step of heat treatment of the wafers supported by the support device when it is being used in a vertical oven.

In one embodiment, the support members are distributed substantially uniformly along the central axis.

15 Accordingly, such a distribution enables much better equilibrium of the wafers.

The present invention also relates to a support device for a plurality of wafers, the support device being adapted to be loaded into a heat treatment oven, the support device having a central axis, the support device including:

- 20 - three uprights extending substantially parallel to the central axis,
- a plurality of series of support members spaced along the central axis, each series of support members comprising three support members delimiting a central area, the three support members of the series of support members being adapted to support one wafer of the plurality of wafers in
- 25 the central area, the central areas of all the series of support members defining a cylinder the axis of which is the central axis, the three support members of each series extending in different essentially longitudinal directions transverse to the central axis, each support member being connected to a separate upright, each series of support members includes at
- 30 least two connecting arms, each connecting arm being adapted to connect a support member to an upright, each connecting arm being contained within a peripheral area of the cylinder,

said support device being remarkable in that the directions of the three support members of each series of support members are concurrent at a point on the central axis.

5 By peripheral area is meant the area adjacent the central cylinder and extending radially relative to the central cylinder.

Accordingly, when the support device supports a plurality of wafers and is being used in a vertical oven, the directions of the three support members of each series of support members concurrent at a point on the central axis enable the radial radiant flux to propagate uniformly.

10 The presence of the connecting arms makes it possible to decorrelate the distribution of the connecting members and the uprights. Thus the function of a connecting arm is to offset the support member relative to the upright to which it is connected. This advantageously minimizes the overall size of the support device and thus enables use of said support device in a
15 vertical oven of smaller volume.

The disposition of the connecting arms in the peripheral area makes it possible to avoid any disturbance or blocking of any of the radiant flux when the device is being used. The temperature distribution of the wafer during a heat treatment step in a vertical oven is therefore uniform.

20 In one embodiment, the support device comprises a cylinder portion and a peripheral area portion, the cylinder portion being the volume of the cylinder contained between two successive central areas along the central axis and the peripheral area portion extending radially relative to the cylinder portion, the connecting arms being disposed in the peripheral area portion.

25 By peripheral area portion is meant the area adjacent the cylinder portion and extending radially relative to the cylinder portion.

Accordingly, this disposition of the connecting arms advantageously prevents them from constituting an obstacle to the propagation of the radiant flux towards the wafers.

30 In one embodiment, the support members of each series of support members are adapted to form an essentially point contact with the corresponding wafer.

Accordingly, holding the wafers so that there is an essentially point contact with the wafer makes it possible to minimize the area of contact between the wafers and the support members.

Moreover, minimizing the area of contact between the wafers and the support members makes it possible to improve the radiant flux during a step of heat treatment of the wafers supported by the support device when it is being used in a vertical oven.

In one embodiment, the uprights are disposed, in cross section, in an angular space around the central axis less than 180° .

In one embodiment, the support members of each series of support members are transversely distributed substantially uniformly along the central axis.

Accordingly, the uniform distribution of the support members around the central axis of the support members advantageously achieves completely radial symmetry of each series of support members.

Moreover, such a distribution enables much better equilibrium of the wafers.

The invention is advantageously completed by the following features separately or in any technically feasible combination:

- the connecting arms are straight,
- the connecting arms are curved.

The two inventions presented above are linked to form a single inventive general concept consisting in the directions of the three support members of each series being concurrent at a point on the central axis.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features, aims and advantages of the invention will emerge from the following description, which is purely illustrative and is not limiting in the invention, and which should be read in conjunction with the appended drawings in which, in addition to Figures 1A, 1B and 2 already discussed:

- Figures 3A to 3C are diagrams showing the support device in accordance with the invention;

- Figures 4A to 4C are diagrams showing the support device in accordance with the invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

For the various embodiments, to simplify the description, the same
5 references are used for elements that are identical or have the same function.

The support device shown in Figures 3A to 3C is a device for supporting a plurality of wafers, the support device 110 being adapted to be loaded into a heat treatment oven, the support device 110 having a central
10 axis X'-X, the support device 110 including:

- three uprights 130, 131 and 132 extending substantially parallel to the central axis X'-X,
- a plurality of series of support members 135 spaced along the central axis X'-X, each series of support members 135 comprising three support
15 members 140, 141 and 142 adapted to support one wafer W of the plurality of wafers and extending in different essentially longitudinal directions transverse to the central axis X'-X, each support member 140, 141 and 142 being mounted directly on a separate upright and the directions of the three support members 140, 141 and 142 of each series of support members 135
20 are concurrent at a point on the central axis.

The uprights 130, 131 and 132 are advantageously the same length and are parallel to the central axis X'-X of the support device 110.

The uprights 131 and 132 have a lateral spacing at least equal to the diameter of the wafers that the support device 110 is adapted to support.
25 This is to allow wafers W to pass between the uprights 131 and 132 in a horizontal position.

In a particularly advantageous manner, the uprights 130, 131 and 132 are equidistant from the central axis X'-X.

The series of support members 135 are spaced along the central axis
30 X'-X. Each series of support members 135 is adapted to support one wafer W in a horizontal position when the support device 110 is being used.

Each series of support members comprises three support members 140, 141 and 142. The support members 140, 141 and 142 of each series of support members 135 are mounted directly on the uprights 130, 131 and 132, respectively.

- 5 The support members 140, 141 and 142 of a series of support members 135 are disposed so as to support one wafer W essentially horizontally in a stable equilibrium position.

The support members extend in different directions, said directions being concurrent at a point on the central axis X'-X.

- 10 In a particularly advantageous manner, as shown in Figure 3C, the support members 140, 141 and 142 of each series of support members 135 are adapted to make an essentially point contact with the corresponding wafer. The angle between a support member and a perpendicular to the upright on which it is mounted is preferably less than 5°.

- 15 The support members 140, 141 and 142 are advantageously distributed substantially uniformly along the central axis.

The present invention also relates to another support device.

- The support device shown in Figures 4A-4C is a support device for a plurality of wafers, the support device 210 being adapted to be loaded into a heat treatment oven, the support device 210 having a central axis X'-X, the support device 210 including:

- three uprights 230, 231 and 232 extending substantially parallel to the central axis 210,
- a plurality of series of support members 235 spaced along the central axis X'-X, each series of support members 235 comprising three support members 240, 241 and 242 delimiting a central area ZC, the three support members 240, 241 and 242 of the series of support members 235 being adapted to support one wafer W from the plurality of wafers in the central area ZC, the central areas ZC of all the series of support members 235 defining a cylinder CC the axis of which is the central axis X'-X, the three support members 240, 241 and 242 of each series 235 extending in different

essentially longitudinal directions transverse to the central axis $X'-X$, each of the support members 240, 241 and 242 being connected to a separate upright, each series of support members 235 includes at least two connecting arms 250, each connecting arm 250 being adapted to connect a support member to an upright, each connecting arm 250 being contained
 5 within a peripheral area ZP of the cylinder CC , and the directions of the three support members 240, 241 and 242 of each series of support members are concurrent at a point on the central axis $X'-X$.

The uprights 230, 231 and 232 are advantageously the same length
 10 and are parallel to the central axis of the support device 210.

In a particularly advantageous manner, the uprights 230, 231 and 232 are equidistant from the central axis $X'-X$.

The series of support members 235 are spaced along the central axis $X'-X$. Each series of support members 235 is adapted to support one wafer
 15 W in a horizontal position when the support device 210 is being used.

Each series of support members 235 comprises three support members 240, 241 and 242.

The support members 240, 241 and 242 of a series of support members 235 are disposed so as to support one wafer W substantially
 20 horizontally in a stable equilibrium position in a central area ZC corresponding to the area occupied by a wafer W . Said central area ZC defines a cylinder CC centred on the central axis $X'-X$. At least two of the support members 240, 241 and 242 of each series of support members 235 are connected to the uprights 230, 231 and 232, respectively, of the different
 25 connecting arms 250. The connecting arms 250 are disposed in a peripheral area ZP of the central cylinder CC .

The support members 240, 241 and 242 extend in different directions, said directions being concurrent at a point on the central axis $X'-X$.

In a particularly advantageous manner, the support device comprises
 30 a cylinder portion PC and a peripheral area portion PP , the cylinder portion PC being the volume of the cylinder CC contained between two successive central areas ZC along the central axis $X'-X$ and the peripheral area portion

PP extending radially relative to the cylinder portion, the connecting arms 250 being disposed in the peripheral area portion PP.

5 The support members 240, 241 and 242 of each series of support members 235 are advantageously adapted to form an essentially point contact with the corresponding wafer.

The uprights 230, 231 and 232 are advantageously disposed, in cross section, in an angular space around the central axis X'-X less than 180°.

10 The support members 240, 241 and 242 of each series of support members 235 are advantageously transversely distributed substantially uniformly along the central axis X'-X.

The connecting arms are advantageously straight or curved.

15 The execution of a step of heat treatment of wafers disposed in a support device in accordance with the invention, said device being inserted into a vertical oven, enables greater uniformity of the wafers to be obtained. This result is valid for a support device whether it is equipped with connecting arms or not.

Thus the invention makes it possible to limit blocking of any of the radiant flux by the support members, thus enabling the uniformity of the heat treatment of the wafers to be improved.

CLAIMS

1. Support device for a plurality of wafers, the support device (210) being adapted to be loaded into a heat treatment oven, the support device (210) having a central axis (X'-X), the support device (210) including:

- three uprights (230), (231) and (232) extending substantially parallel to the central axis (210),

- a plurality of series of support members (235) spaced along the central axis (X'-X); each series of support members (235) comprising three support members (240), (241) and (242) delimiting a central area (ZC), the three support members (240), (241) and (242) of the series of support members (235) being adapted to support one wafer (W) of the plurality of wafers in the central area (ZC), the central areas (ZC) of all the series of support members (235) defining a cylinder (CC) the axis of which is the central axis (X'-X), the three support members (240), (241) and (242) of each series (235) extending in different essentially longitudinal directions transverse to the central axis (X'-X), each support member (240), (241) and (242) being connected to a separate upright, each series of support members (235) includes at least two connecting arms (250), each connecting arm (250) being adapted to connect a support member to an upright, each connecting arm (250) being contained within a peripheral area (ZP) of the cylinder (CC), said support device being **characterized in that** the directions of the three support members (240), (241) and (242) of each series of support members are concurrent at a point on the central axis (X'-X).

2. Support device according to Claim 1, comprising a cylinder portion (PC) and a peripheral area portion (PP), the cylinder portion (PC) being the volume of the cylinder (CC) contained between two successive central areas (ZC) along the central axis (X'-X) and the peripheral area portion (PP) extending radially relative to the cylinder portion, the connecting arms (250) being disposed in the peripheral area portion (PP).

3. Support device according to either one of Claims 1 or 2, wherein the support members (240), (241) and (242) of each series of support members (235) are adapted to form an essentially point contact with the corresponding wafer.

4. Support device according to any one of Claims 1 to 3, wherein the uprights are disposed, in cross section, in an angular space around the central axis less than 180°.

5. Support device according to any one of Claims 1 to 4, wherein the support members (240), (241) and (242) of each series of support members (235) are transversely distributed substantially uniformly along the central axis.

6. Support device according to any one of Claims 1 to 5, wherein the connecting arms (250) are straight.

7. Support device according to any one of Claims 1 to 5, wherein the connecting arms (250) are curved.