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(54) SUSCEPTOR IMPROVEMENT

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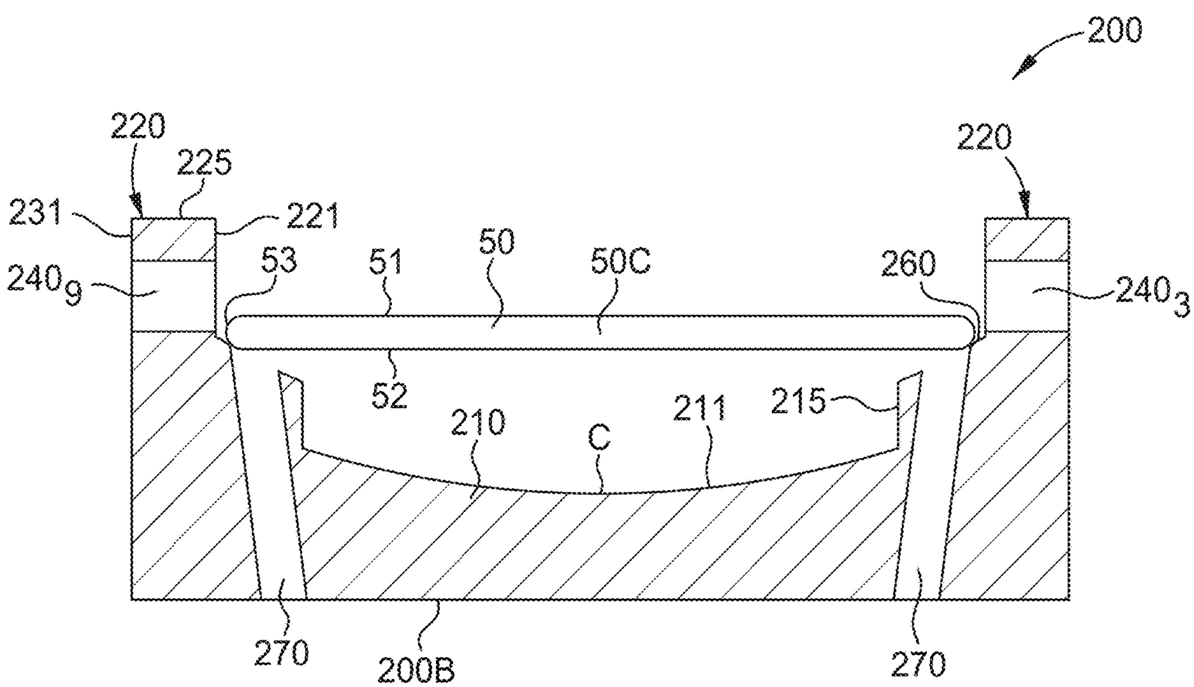
(57) **ABSTRACT**

A susceptor for a processing chamber is provided including: an inner portion having a center; an outer rim disposed around the inner portion, the outer rim including a first inner side surface and a first outer side surface; and a plurality of apertures, each aperture extending from the first outer side surface to the first inner side surface. Each aperture of the plurality of apertures is located at a different angular location relative to the center of the inner portion.



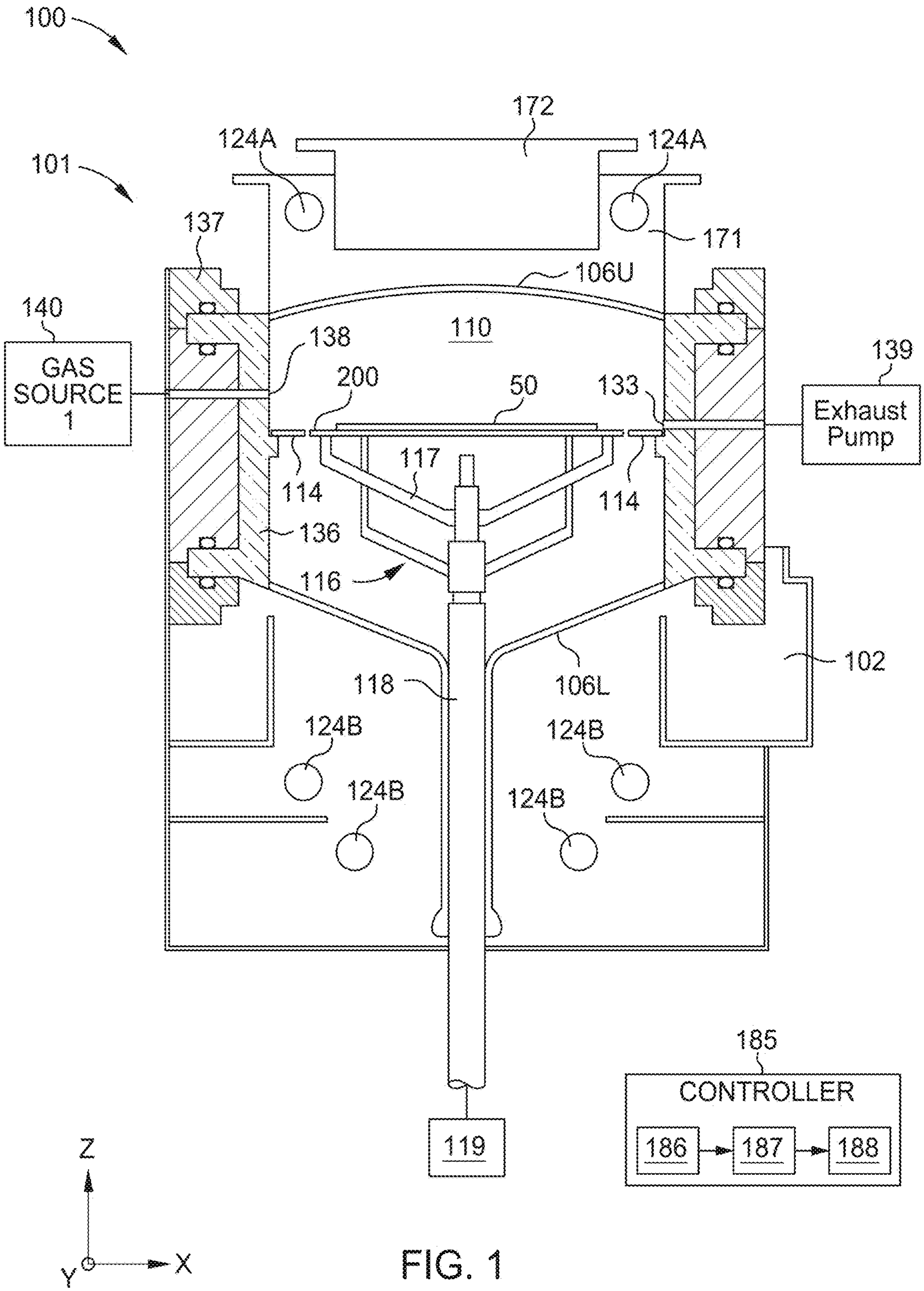
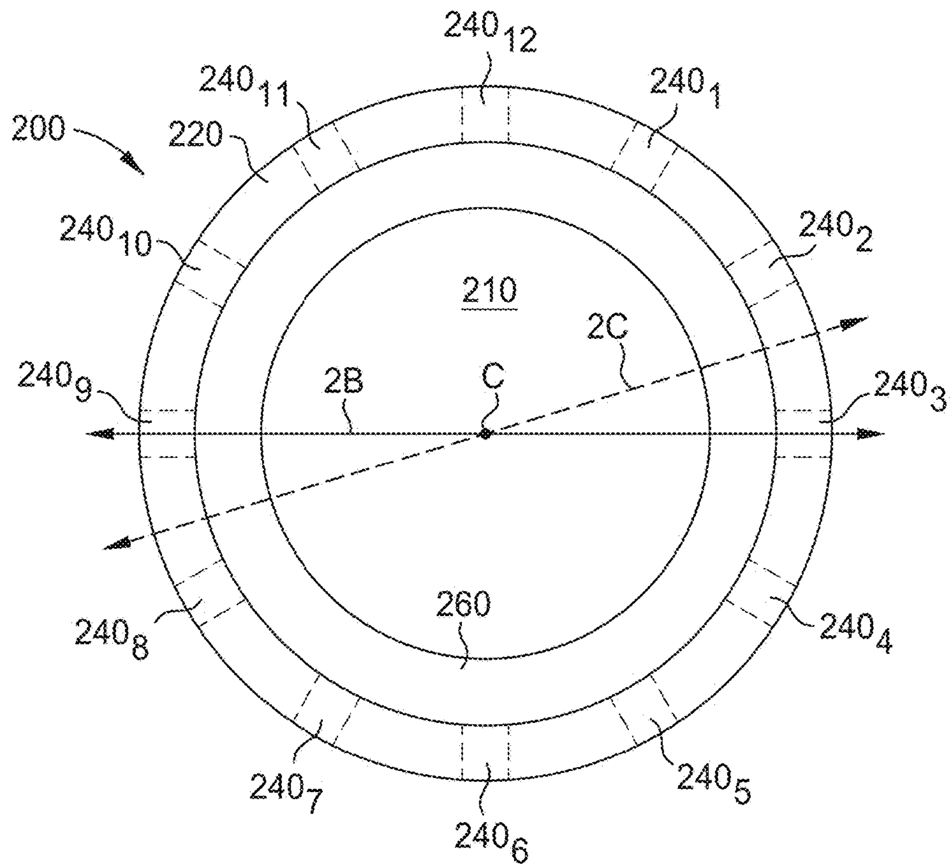
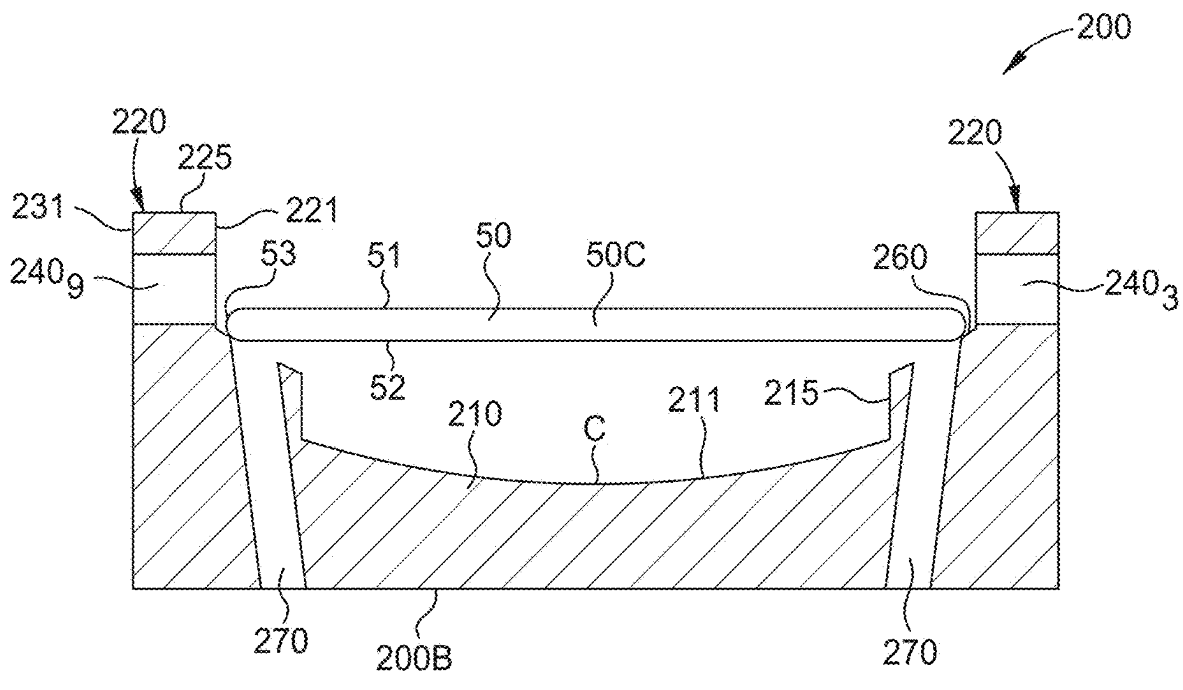

100
101
172
124A
124A
137
171
106U
140
GAS SOURCE 1
138
110
139
200
50
133
Exhaust Pump
117
114
114
136
116
102
118
106L
124B
124B
124B
124B
185
CONTROLLER
186
187
188
119
Z
Y
X

FIG. 1



240_{12}
240_{11}
240_1
200
220
240_{10}
240_2
210
2C
240_9
2B
C
240_3
260
240_8
240_4
240_7
240_5
240_6

FIG. 2A



200
220
225
220
231
221
53
51
50
50C
260
240_9
240_3
52
210
211
215
C
270
200B
270

FIG. 2B

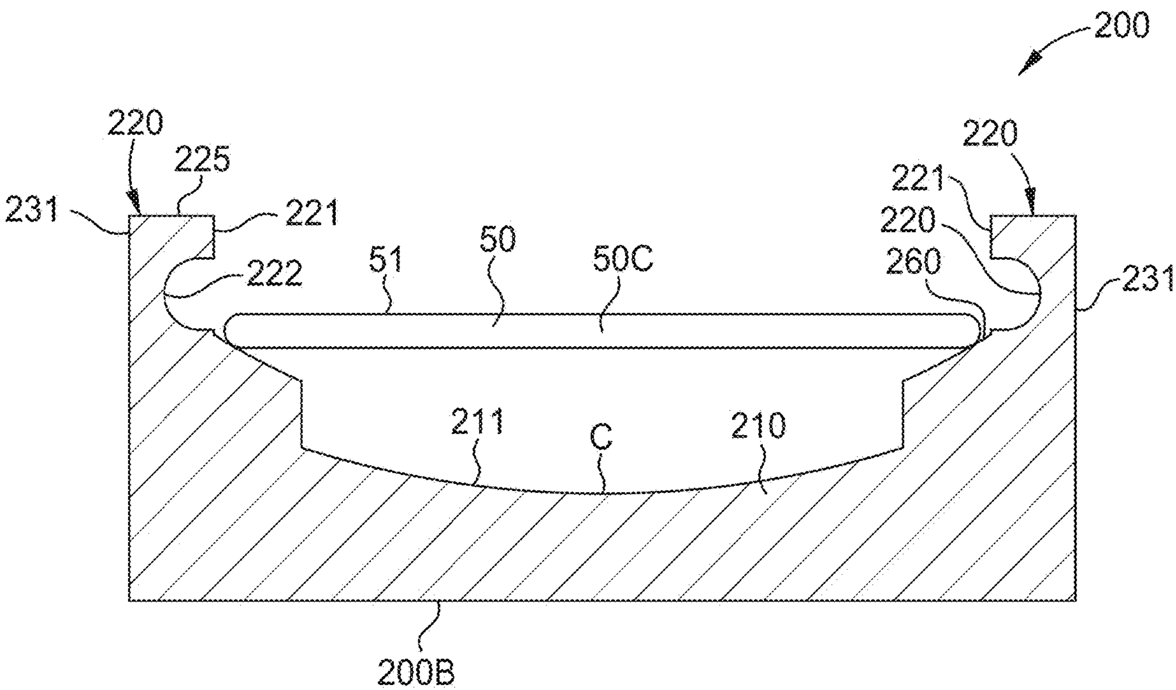
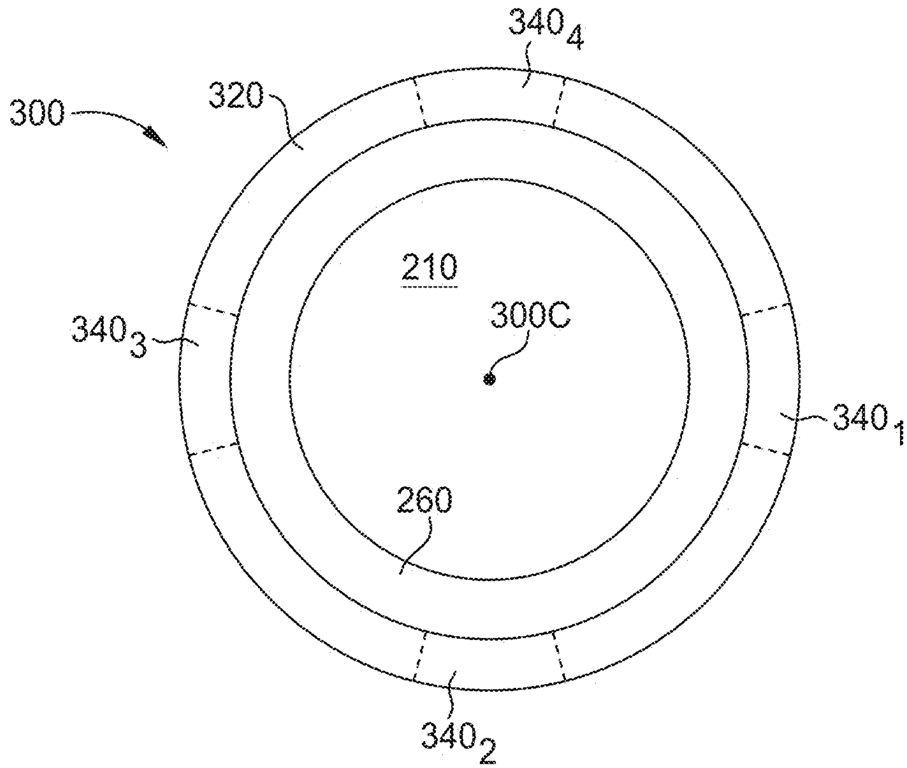
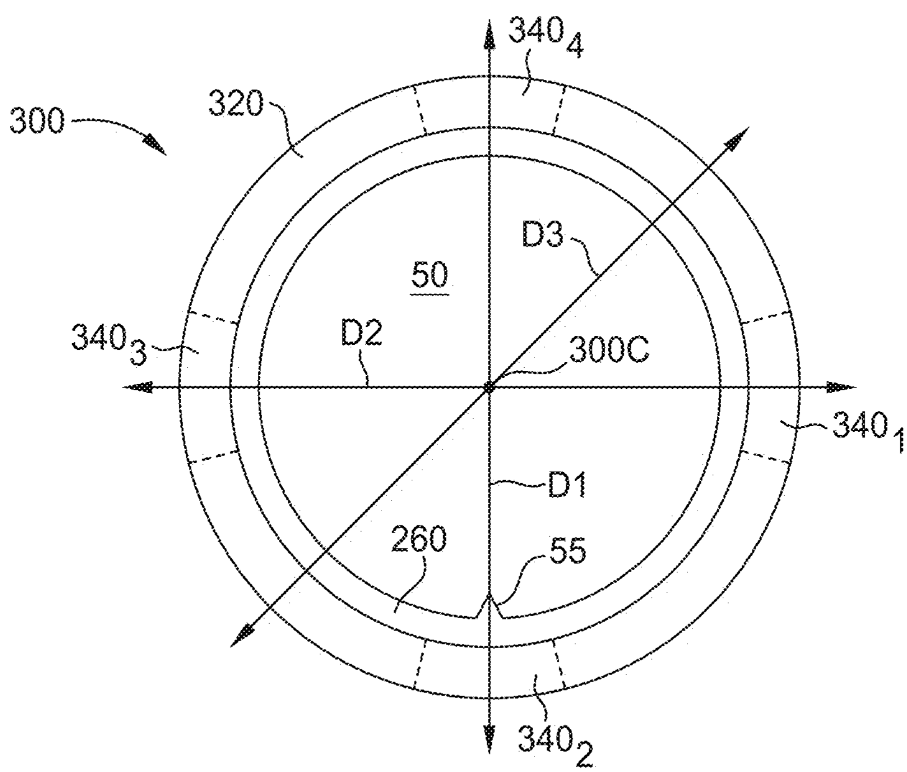

200
220
225
231
221
222
51
50
50C
220
221
220
260
231
211
C
210
200B

FIG. 2C



340_4
300
320
210
300C
340_3
340_1
260
340_2

FIG. 3A



340_4
300
320
D3
50
340_3
D2
300C
340_1
D1
260
55
340_2

FIG. 3B

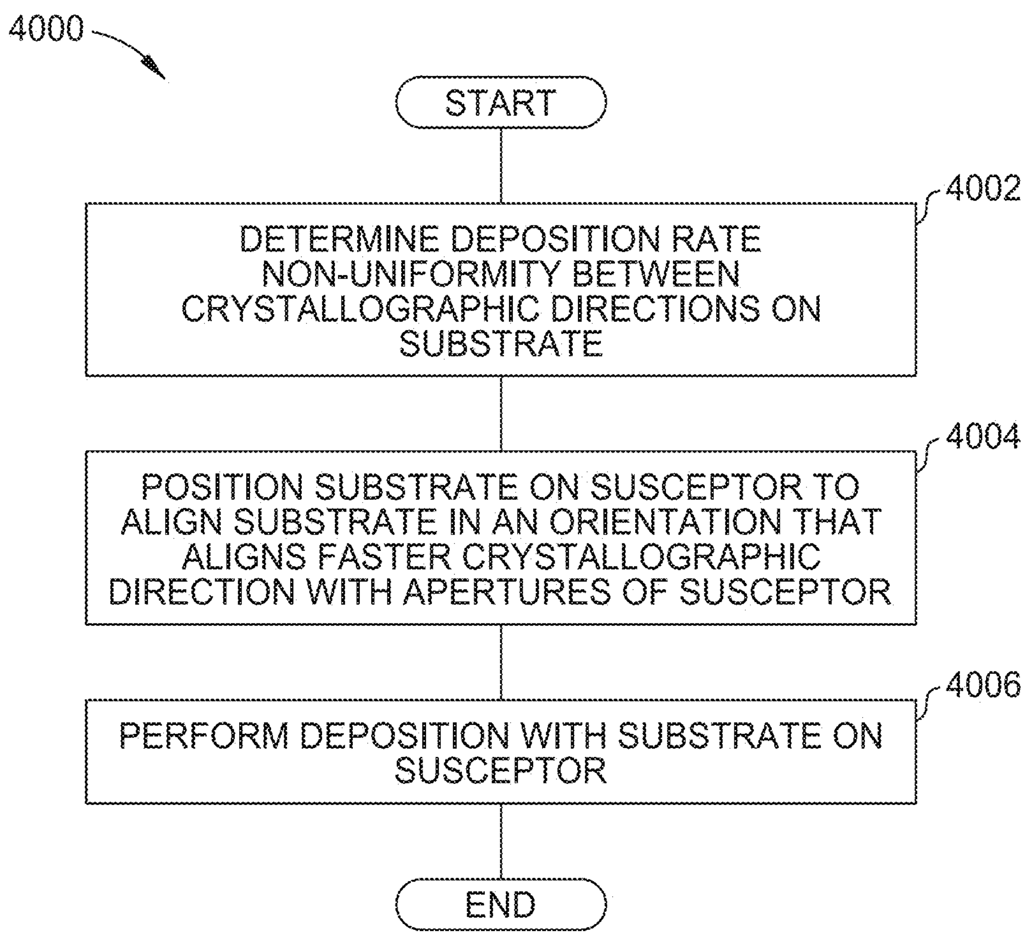

4000
START
4002
DETERMINE DEPOSITION RATE NON-UNIFORMITY BETWEEN CRYSTALLOGRAPHIC DIRECTIONS ON SUBSTRATE
4004
POSITION SUBSTRATE ON SUSCEPTOR TO ALIGN SUBSTRATE IN AN ORIENTATION THAT ALIGNS FASTER CRYSTALLOGRAPHIC DIRECTION WITH APERTURES OF SUSCEPTOR
4006
PERFORM DEPOSITION WITH SUBSTRATE ON SUSCEPTOR
END

FIG. 4

SUSCEPTOR IMPROVEMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit of U.S. provisional patent application Ser. No. 63/555,479, filed Feb. 20, 2024, which is hereby incorporated herein by reference.

BACKGROUND

Field

[0002] Embodiments of the present disclosure generally relate to susceptors for use in processing of substrates (e.g., semiconductor substrates), and more particularly to susceptors having features to improve process uniformity across a substrate during processing.

Description of the Related Art

[0003] Susceptors are often used in epitaxy processes to support a substrate as well as to heat the substrate to a highly uniform temperature. Susceptors often have platter or dish-shaped upper surfaces that are used to support a substrate from below around the edge(s) of the substrate while leaving a small gap between the remaining lower surface of the substrate and the upper surface of the susceptor. Precise control over a heating source, such as a plurality of heating lamps disposed below the susceptor, allows a susceptor to be heated within very strict tolerances. The heated susceptor can then transfer heat to the substrate, primarily by radiation emitted by the susceptor.

[0004] Despite the precise control of heating the susceptor in epitaxy, temperature non-uniformities persist across the upper surface of the substrate often reducing the quality of the process (e.g., deposition) being performed on the substrate. For example, the deposition rate near the edge of the substrate can be different than for other portions of the substrate. Furthermore, deposition rates can also vary in different crystallographic directions, which can also add to deposition thickness non-uniformities across the substrate. Therefore, an ongoing need exists for addressing non-uniformities.

SUMMARY

[0005] Embodiments of the present disclosure generally relate to susceptors for use in processing of substrates (e.g., semiconductor substrates), and more particularly to susceptors having features to improve process uniformity across a substrate during processing.

[0006] In one embodiment, a susceptor for a processing chamber is provided comprising: an inner portion having a center; an outer rim disposed around the inner portion, the outer rim including a first inner side surface and a first outer side surface; and a plurality of apertures, each aperture extending from the first outer side surface to the first inner side surface, wherein each aperture of the plurality of apertures is located at a different angular location relative to the center of the inner portion.

[0007] In another embodiment, a process chamber is provided comprising: a chamber body disposed around an interior volume; a substrate support assembly comprising: a shaft and a susceptor configured to be rotated by the shaft, the susceptor disposed in the interior volume and comprising: an inner portion having a center; an outer rim disposed around the inner portion, the outer rim including a first inner side surface and a first outer side surface; and a plurality of apertures, each aperture extending from the first outer side surface to the first inner side surface, wherein each aperture of the plurality of apertures is located at a different angular location relative to the center of the inner portion.

[0008] In another embodiment, a method of processing a substrate is provided comprising: positioning a substrate on a susceptor in an interior volume of a process chamber, the susceptor comprising: an inner portion having a center; an outer rim disposed around the inner portion, the outer rim including a first inner side surface and a first outer side surface; and a plurality of apertures, each aperture extending from the first outer side surface to the first inner side surface, wherein each aperture of the plurality of apertures is located at a different angular location relative to the center of the inner portion; and performing a first process on the substrate by providing one or more process gases to the interior volume of the process chamber while rotating the susceptor to deposit a layer on the substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only exemplary embodiments and are therefore not to be considered limiting of its scope, and may admit to other equally effective embodiments.

[0010] FIG. **1** is a cross-sectional view of a processing system, according to one embodiment.

[0011] FIG. **2**A is a top view of the susceptor from FIG. **1**, according to one embodiment.

[0012] FIG. **2**B is a side cross-sectional view of the susceptor taken along section line **2**B of FIG. **2**A, according to one embodiment.

[0013] FIG. **2**C is a side cross-sectional view of the susceptor taken along section line **2**C of FIG. **2**A, according to one embodiment.

[0014] FIG. **3**A is a top view of a susceptor, according to one embodiment.

[0015] FIG. **3**B is a top view of a substrate positioned on the susceptor, according to one embodiment.

[0016] FIG. **4** is a process flow diagram of a method for processing a substrate, according to one embodiment.

[0017] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is contemplated that elements and features of one embodiment may be beneficially incorporated in other embodiments without further recitation.

DETAILED DESCRIPTION

[0018] Embodiments of the present disclosure generally relate to susceptors and related methods for use in processing of substrates (e.g., semiconductor substrates), and more particularly to susceptors having features to improve process uniformity across a substrate during processing. The susceptors disclosed herein can improve the uniformity of the process being performed on the substrate supported by the susceptor by improving the gas flow over the substrate during processing. The susceptor can include a plurality of apertures that extend through an outer component of the susceptor, such as an outer rim of the susceptor. Each aperture of the plurality of apertures directs the gas along a gas flow path through the outer component and over an inner portion of the susceptor. The substrate is supported over the inner portion of the susceptor during processing, so the gas directed through the plurality of apertures flows along a gas flow path over the substrate during processing. Flowing at least some of the gas through the plurality of apertures in the outer component of the susceptor during processing can increase the concentrations of gas and/or residence time of the gases over the edge regions of the substrate relative to otherwise similar processes performed on the susceptors lacking the plurality of apertures in the outer component.

[0019] These increased concentrations and/or residence times of the gases can be used to improve the uniformity (e.g., deposition thickness uniformity) of the process being performed, especially in situations in which the process rate (e.g., deposition rate) is slower at the edge of the substrate than the corresponding process rate at the center of the substrate when a conventional susceptor is used. The residence time of gases over different portions of the substrate (e.g., edge versus center) can be more challenging in process chambers using a cross-flow path over the substrate (e.g., a substantially horizontal path), such as the epitaxial deposition chamber described below in FIG. **1**, when compared to process chambers that provide gas to the interior volume using a component disposed over the substrate, such as a showerhead. The susceptors disclosed herein can be used to overcome these challenges relating to gas concentration and residence time uniformity. Furthermore, in some embodiments (see FIG. **2**C), the outer component (e.g., outer rim) of the susceptor can include a recessed region to increase the volume of space near the edge of the substrate during processing, which can also improve process uniformity.

[0020] The susceptors disclosed herein can also be used to reduce non-uniformities for deposition growth rates in different crystallographic directions. For example, in some embodiments (see e.g., FIGS. **3**A and **3**B), the susceptor disclosed herein can be used to reduce non-uniformities between the growth rate in the <100> direction and the growth rate in the <110> direction. Reducing non-uniformities for growth rates in different crystallographic directions improves the uniformity of the process being performed (e.g., the layer being deposited on the substrate) and eventually leads to an improved end product.

[0021] Although the following describes the benefits of this disclosure in reference to an epitaxial deposition process, the benefits of this disclosure can more generally be applied to any process that uses a susceptor or substrate support having an outer component (e.g., an outer rim) disposed around an inner component (e.g., an inner portion).

[0022] FIG. **1** is a cross-sectional view of a processing system **100**, according to one embodiment. The processing system **100** includes a process chamber **101**, a gas supply source **140**, an exhaust pump **139**, and a controller **185**. The processing system **100** can be configured to perform epitaxial deposition processes in the process chamber **101** as well as other processes, such as cleaning processes.

[0023] The process chamber **101** includes a chamber body **102**. In some embodiments, the chamber body **102** can be made of a process resistant material, such as aluminum or stainless steel, for example 316L stainless steel. The chamber body **102** is disposed around structural components of the process chamber **101**, such as an upper window **106**U, a lower window **106**L, an inner liner **136**, and an outer liner **137**. In one embodiment, the windows **106**U, **106**L can each be formed of quartz. The liners **136**, **137** can be positioned between the windows **106**U, **106**L and the chamber body **102** to insulate the windows **106**U, **106**L from the chamber body **102**. The windows **106**U, **106**L and the liners **136**, **137** enclose an interior volume **110** (also referred to as process volume) of the process chamber **101**. The process chamber **101** can further include a gas inlet **138** extending through the liners **136**, **137** to provide a gas flow path into the interior volume **110** from outside of process chamber **101**.

[0024] The process chamber **101** includes a substrate support assembly **116**. The substrate support assembly **116** can include supports **117** and a shaft **118**. A susceptor **200** can be positioned on the supports **117**. A substrate **50** is positioned on the susceptor **200**. A simplified illustration of the susceptor **200** is shown in FIG. **1**. Additional detail on the susceptor **200** is shown in FIGS. **2**A-**2**C. An alternative susceptor **300** is described below in reference to FIGS. **3**A and **3**B. The substrate support assembly **116** can further include an actuator **119** to rotate the shaft **118**, the susceptor **200**, and substrate **50** during processing, such as during an epitaxial deposition.

[0025] Gases can be introduced into the interior volume **110** from the gas supply source **140** during depositions, cleaning, or other processes. These gases can be exhausted from the interior volume **110** through an exhaust outlet **133** by the exhaust pump **139**. The process chamber **101** can further include a preheat ring **114** that can be positioned around the susceptor **115**.

[0026] The process chamber **101** can further include upper lamp modules **124**A and lower lamp modules **124**B for heating of the substrate **50** and/or the interior volume **110**. In one embodiment, the upper lamp modules **124**A and the lower lamp modules **124**B are infrared (IR) lamps.

[0027] The process chamber **101** further includes an outer reflector **171** and an inner reflector **172** positioned over the upper window **106**U. The outer reflector **171** can be positioned around the inner reflector **172**. In some embodiments one or more upper lamp modules **124**A can be positioned inside the outer reflector **171**.

[0028] The processing system **100** also includes the controller **185** for controlling processes performed by the processing system **100**. The controller **185** can be any type of controller used in an industrial setting, such as a programmable logic controller (PLC). The controller **185** includes a processor **187**, a memory **186**, and input/output (I/O) circuits **188**. The controller **185** can further include one or more of the following components (not shown), such as one or more power supplies, clocks, communication components (e.g., network interface card), and user interfaces typically found in controllers for semiconductor equipment.

[0029] The memory **186** can include non-transitory memory. The non-transitory memory can be used to store the programs and settings described below. The memory **186** can include one or more readily available types of memory, such as read only memory (ROM) (e.g., electrically erasable programmable read-only memory (EEPROM), flash memory, floppy disk, hard disk, or random access memory (RAM) (e.g., non-volatile random access memory (NVRAM).

[0030] The processor **187** is configured to execute various programs stored in the memory **186**, such as epitaxial deposition processes and purging processes. As one example, the controller **185** can be used to execute a program stored in the memory **186** to perform many of the operations described below in reference to FIG. **4**. During execution of these programs, the controller **185** can communicate to I/O devices through the I/O circuits **188**. For example, during execution of these programs and communication through the I/O circuits **188**, the controller **185** can control outputs, such as the position of valves to send process gases to the interior volume **110** of the process chamber **101** or to perform purging processes. The memory **186** can further include various operational settings used to control the processing system **100**. For example, the settings can include durations for how long the different valves remain open or closed during different depositions and purging processes.

[0031] FIG. **2**A is a top view of the susceptor **200** from FIG. **1**, according to one embodiment. FIG. **2**B is a side cross-sectional view of the susceptor **200** taken along section line **2**B of FIG. **2**A, according to one embodiment. The following paragraphs describe the susceptor **200** with reference to FIGS. **2**A and **2**B.

[0032] The susceptor **200** includes an inner portion **210** and an outer rim **220** that is disposed around the inner portion **210**. In some embodiments, the inner portion **210** can be referred to as inner dish or inner pocket, but a dish shape or pocket shape is not required. In some embodiments, the outer rim **220** fully surrounds the inner portion **210**. The inner portion **210** includes a first surface **211** that is configured to face the bottom of the substrate **50** during processing. The first surface **211** can include a center C, which is also referred to as the center C of the susceptor **200**. In some embodiments, the first surface **211** can have a concave profile, for example as shown, with the center C of first surface **211** spaced further apart from the substrate **50** during processing than outer regions of the first surface **211** are spaced apart from the substrate **50**. A center **50**C of the substrate **50** can overlie the center C of the top surface **211** of the inner portion **210**. The inner portion **210** can further include an outer wall **215** extending above the first surface **211**. The substrate **50** includes a top surface **51** (first surface), a bottom surface **52** (second surface), and one or more sides **53** connecting the top surface **51** with the bottom surface **52**.

[0033] The outer rim **220** can include a first inner side surface **221** and a first outer side surface **231**. The outer rim **220** can further include a top surface **225** connecting the first inner side surface **221** with the first outer side surface **231**. In some embodiments, the susceptor can include one or more additional surfaces (not shown) that can connect the first inner side surface **221** with the first outer side surface **231**.

[0034] The susceptor **200** further includes a supporting structure **260** that connects the inner portion **210** to the outer rim **220**. The substrate **50** can be positioned on the supporting structure **260** during processing. Only a portion of the bottom surface **52** of the substrate **50** near the one or more sides **53** of the substrate **50** is positioned on the supporting structure **260** during processing, so that the vast majority of the bottom surface **52** of the substrate **50** does not contact the susceptor **200** during processing. The supporting structure **260** is shown as an angled surface in FIG. **2**B, but other structures can also be used, such as an annular ridge extending upward and around the inner portion **210** at substantially the same location as the angled surface shown in FIG. **2**B. The angled surface of the supporting structure **260** can extend downwardly from the outer rim **220** to the inner portion **210**.

[0035] The susceptor **200** further includes a plurality of apertures **240** with each aperture **240** extending through the outer rim **220** from the first outer side surface **231** to the first inner side surface **221**. Each aperture **240** can be located above the inner portion **210**. Each aperture **240** can also be located above the supporting structure **260**. The apertures **240** can each be configured to provide a gas flow path for some of the gases provided to the interior volume **110** to flow through the apertures **240** and over the inner portion **210** and the top surface **51** of the substrate **50** during processing. More generally, each aperture **240** can be configured to provide a gas flow path for directing gas from a first location outside the outer rim **220** to a second location inside the outer rim **220** and over the inner portion **210**. Apertures that can direct gas from outside the outer rim of a susceptor to a location inside the outer rim and over an inner portion of the susceptor can help improve the process uniformity of the process (e.g., deposition) being performed on a substrate supported by the susceptor because these apertures improve the uniformity of the gas concentrations over the substrate during processing, such as center to edge gas concentration uniformity. Other gases provided to the interior volume **110** can flow over the top surface **225** of the outer rim **220** before reaching the region of the interior volume **110** overlying the top surface **51** of the substrate **50**, which is the only gas flow path for processes performed using conventional susceptors.

[0036] The susceptor **200** is shown as including twelve apertures $\mathbf{240}_1$-$\mathbf{240}_{12}$, but other embodiments can include more or fewer apertures **240**. In some embodiments, for example as shown in FIG. **2**B, each aperture **240** of the plurality of apertures **240** can be located at a different angular location relative to the center C of the inner portion **210**. However, in other embodiments (not shown), two or more apertures can have a same angular location, such as a first aperture overlying a second aperture. As described above in reference to FIG. **1**, the substrate support assembly **116** can further include the actuator **119** configured to rotate the susceptor **200** during processing. This rotation can allow each of the apertures **240** to be rotated to a position facing the gas inlet **138** during processing, so that the gas flowrates through each of the apertures **240** during processing is substantially the same.

[0037] The plurality of apertures **240** can increase the uniformity of the concentration of gases and residence times for the gases over the top surface **51** of substrate **50**, so that there is less variation between concentration and residence times of the gases over the center **50**C of the substrate **50** relative to the edge of the substrate **50** near the one or more side surfaces **53**. By improving the uniformity of the concentration and residence times of the gases over the entire top surface **51** of the substrate **50**, the uniformity (e.g., deposition thickness uniformity) of the corresponding process can also be improved. For example, using the susceptor **200** having the plurality of apertures **240** during process can improve deposition thickness uniformity on the top surface **51** of the substrate during an epitaxial deposition performed in the process chamber **101** (see FIG. **1**) compared to the same process performed on an otherwise similar susceptor that does not include the apertures **240**.

[0038] In some embodiments, the susceptor **200** can include a plurality of channels **270**, each channel **270** extending from a first opening between the supporting structure **260** and the outer wall **215** of the inner portion **210** to a second opening at a bottom **200**B of the susceptor **200**. The plurality of channels **270** can be used to remove any gases that reach the region of the interior volume **110** between the bottom surface **52** of the substrate **50** and a portion of the susceptor **200**, so that unintended processes (e.g., backside deposits) on the substrate **50** can be prevented.

[0039] FIG. **2**C is a side cross-sectional view of the susceptor **200** taken along section line **2**C of FIG. **2**A, according to one embodiment. The view in FIG. **2**C shows the cross-sectional view of the susceptor **200** at locations other than locations including one or more of the apertures **240**. In some embodiments, the outer rim **220** can additionally include a second inner side surface **222** below the first inner side surface **221**. The first inner side surface **221** can be located more inwardly towards the center C of the susceptor **200** relative to the second inner side surface **222**. The second inner side surface **222** can curve outwardly away from the first inner side surface **221** and then curve inwardly to the angled surface of the supporting structure **260**. In some embodiments, for example as shown in FIG. **2**C, the second inner side surface **222** can have a concave profile. In one embodiment, the second inner side surface **222** can have a C-shaped profile. The outwardly extending second inner side surface **222** can be used to increase the volume available for the process gases inside the outer rim **220** of the susceptor **200** above the top surface **51** of the substrate **50**. In some embodiments, this increase in volume can improve process uniformity (e.g., deposition thickness uniformity) for the edge of the substrate **50** relative to the center **50**C of the substrate **50**.

[0040] FIG. **3**A is a top view of a susceptor **300**, according to one embodiment. The susceptor **300** includes the same inner portion **210** and supporting structure **260** that were included in the susceptor **200**. The susceptor **300** is substantially similar to the susceptor **200** described above except that the susceptor **300** includes an outer rim **320** that is different than the outer rim **220** of the susceptor **200**. The outer rim **320** of the susceptor **300** includes four apertures **340**$_1$-**340**$_4$. The apertures **340** are similar to the apertures **240** described above except that the apertures **340** are larger and there are only four apertures **340** instead of the twelve apertures **240**. Each aperture **340** is positioned at an angular location that is 90 degrees apart from another aperture **340** when the angular location is determined relative to a center **300**C of the susceptor **300**.

[0041] FIG. **3**B is a top view of a substrate **50** positioned on the susceptor **300**, according to one embodiment. The susceptor **300** can be used in the process chamber **101** of FIG. **1** instead of the susceptor **200** described above. The substrate **50** is the same as the substrate **50** described above except that the substrate **50** includes an alignment feature **55** that can assist with aligning the substrate **50** on the susceptor **300**. The alignment feature **55** is shown as a notch, but other alignment features (e.g., a mark) can also be used to align the substrate on the susceptor **300**.

[0042] Processes performed on substrates can often vary in different crystallographic directions. For example, on the substrate **50**, the deposition rate in the <100> direction is faster than the deposition rate in the <110> direction. In this example, the alignment feature **55** and the center **300**C of the substrate **50** are used as reference points for determining crystallographic directions. Using these reference points, the <100> direction is represented by directions D**1** and D**2**, and the <110> direction is represented by the direction D**3**. Another example of the <110> direction could be represented by another line that is orthogonal to the D**3** direction, but this is not shown in order to not clutter the drawing.

[0043] The substrate **50** is positioned on the substrate **50** with the alignment feature **55** aligned with the D**1** direction (i.e., one of the <100> directions). When gas is provided through the apertures **340** during processing as the susceptor **300** is rotated, the deposition rates in the <110> directions become more uniform with the deposition rates in the <100> directions.

[0044] FIG. **4** is a process flow diagram of a method **4000** for processing a substrate, according to one embodiment. The method **4000** can be used to deposit a layer on the substrate. The method **4000** can also be used to improve the process uniformity of a deposition on a substrate for a process that would otherwise have non-uniformities in different crystallographic directions. The method **4000** can be performed in part by the controller **185** from FIG. **1**. Although the method **4000** is described as being performed on the susceptor **300** from FIGS. **3**A, **3**B to improve uniformity in different crystallographic directions, a substantially similar method can also be performed on the susceptor **200** to improve center to edge deposition uniformity. Furthermore, performing a deposition on the susceptor **300** can improve center to edge deposition uniformity in a similar manner as the susceptor **200**.

[0045] The method begins at block **4002**. At block **4002**, it is determined that a deposition performed on a substrate with a conventional susceptor has a deposition growth rate non-uniformity between the crystallographic directions <100> and <110>.

[0046] At block **4004**, the substrate **50** including the alignment feature **55** is transferred into the process chamber **101** (see FIG. **1**) and positioned on the susceptor **300** as shown in FIG. **3**B with the alignment feature **55** aligned with a center of one of the apertures **340**. The alignment feature **55** is aligned with the <100> crystallographic direction D**1**, which is the direction that experienced a higher deposition rate compared to the <110> when the otherwise similar deposition was performed on a conventional susceptor. Each of the apertures **340**$_1$-**340**$_4$ are aligned with the <100> crystallographic directions D**1** and D**2**. The position of the substrate **50** on the susceptor **300** also causes the <110> crystallographic directions to be aligned at angular locations corresponding to the midpoint angular locations between neighboring apertures **340**.

[0047] At block **4006**, the deposition is performed on the substrate **50** that is positioned on the susceptor **300** in the process chamber **101** (see FIG. **1**). The susceptor **300** and the substrate **50** are rotated by the actuator **119** during the deposition. Process gases are provided to the interior volume **110** during the deposition. Some of the process gases provided to the interior volume **110** flow through the apertures **340** during the deposition. By aligning the apertures **340** with the alignment feature **55**, the uniformity of the deposition rates between the crystallographic directions <100>

and <110> is improved when compared to the same deposition performed on a conventional susceptor. After block **4006**, the method **4000** ends.

[0048] While the foregoing is directed to embodiments of the present disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof.

What is claimed is:

1. A susceptor for a processing chamber comprising:
an inner portion having a center;
an outer rim disposed around the inner portion, the outer rim including a first inner side surface and a first outer side surface; and
a plurality of apertures, each aperture extending from the first outer side surface to the first inner side surface, wherein each aperture of the plurality of apertures is located at a different angular location relative to the center of the inner portion.

2. The susceptor of claim **1**, wherein each aperture of the plurality of apertures is located above the inner portion.

3. The susceptor of claim **1**, further comprising a supporting structure that connects the inner portion to the outer rim.

4. The susceptor of claim **3**, wherein the supporting structure is an angled surface.

5. The susceptor of claim **1**, wherein each aperture of the plurality of apertures is positioned at an angular location relative to the center of the inner portion that is at a right angle relative to an angular location of another aperture of the plurality of apertures relative to the center of the inner portion.

6. The susceptor of claim **1**, wherein each aperture of the plurality of apertures is located 180 degrees apart from another aperture of the plurality of apertures relative to the center of the inner portion.

7. The susceptor of claim **1**, wherein the outer rim includes a second inner side surface below the first inner side surface, wherein the first inner side surface extends more inwardly towards the center of the inner portion than the second inner side surface extends towards the center of the inner portion.

8. The susceptor of claim **7**, wherein the second inner side surface has a curved concave profile.

9. A process chamber comprising:
a chamber body disposed around an interior volume;
a substrate support assembly comprising:
a shaft and a susceptor configured to be rotated by the shaft, the susceptor disposed in the interior volume and comprising:
an inner portion having a center;
an outer rim disposed around the inner portion, the outer rim including a first inner side surface and a first outer side surface; and
a plurality of apertures, each aperture extending from the first outer side surface to the first inner side surface, wherein each aperture of the plurality of apertures is located at a different angular location relative to the center of the inner portion.

10. The process chamber of claim **9**, wherein each aperture of the plurality of apertures is located above the inner portion.

11. The process chamber of claim **9**, wherein the susceptor further comprises a supporting structure that connects the inner portion to the outer rim.

12. The process chamber of claim **11**, wherein the supporting structure is an angled surface.

13. The process chamber of claim **9**, wherein each aperture of the plurality of apertures is positioned at an angular location relative to the center of the inner portion that is at a right angle relative to an angular location of another aperture of the plurality of apertures relative to the center of the inner portion.

14. The process chamber of claim **9**, wherein each aperture of the plurality of apertures is located 180 degrees apart from another aperture of the plurality of apertures relative to the center of the inner portion.

15. The process chamber of claim **9**, wherein the outer rim includes a second inner side surface below the first inner side surface, wherein the first inner side surface extends more inwardly towards the center of the inner portion than the second inner side surface extends towards the center of the inner portion.

16. A method of processing a substrate comprising:
positioning a substrate on a susceptor in an interior volume of a process chamber, the susceptor comprising:
an inner portion having a center;
an outer rim disposed around the inner portion, the outer rim including a first inner side surface and a first outer side surface; and
a plurality of apertures, each aperture extending from the first outer side surface to the first inner side surface, wherein each aperture of the plurality of apertures is located at a different angular location relative to the center of the inner portion; and
performing a first process on the substrate by providing one or more process gases to the interior volume of the process chamber while rotating the susceptor to deposit a layer on the substrate.

17. The method of claim **16**, wherein the susceptor includes four apertures extending through the outer rim, each aperture configured to allow the one or more process gases to flow through the aperture during processing.

18. The method of claim **16**, wherein each aperture of the four apertures is positioned at an angular location that is at a right angle relative to another aperture when the angular location is determined relative to a center of the susceptor.

19. The method of claim **18**, wherein the four apertures are the only apertures extending through the outer rim that are configured to allow the one or more process gases to flow through the outer rim.

20. The method of claim **16**, wherein positioning the substrate on the susceptor further comprises aligning the substrate to have an alignment feature on the substrate be aligned with a center of one of the apertures when the substrate is positioned on the susceptor.

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