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(54) **SUBSTRATE CARRIER IMPROVEMENT**

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B05C 5/02 (2006.01)
(Continued)

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CPC ***B05C 5/0291*** (2013.01); ***B05D 3/007*** (2013.01); ***B05D 3/067*** (2013.01); ***B05D 7/24*** (2013.01); *B05D 2203/30* (2013.01)

(58) **Field of Classification Search**
CPC B05C 5/0291; B05D 3/007; B05D 3/067; B05D 7/24; B05D 2203/30; H01L 21/00; H01L 21/6833
See application file for complete search history.

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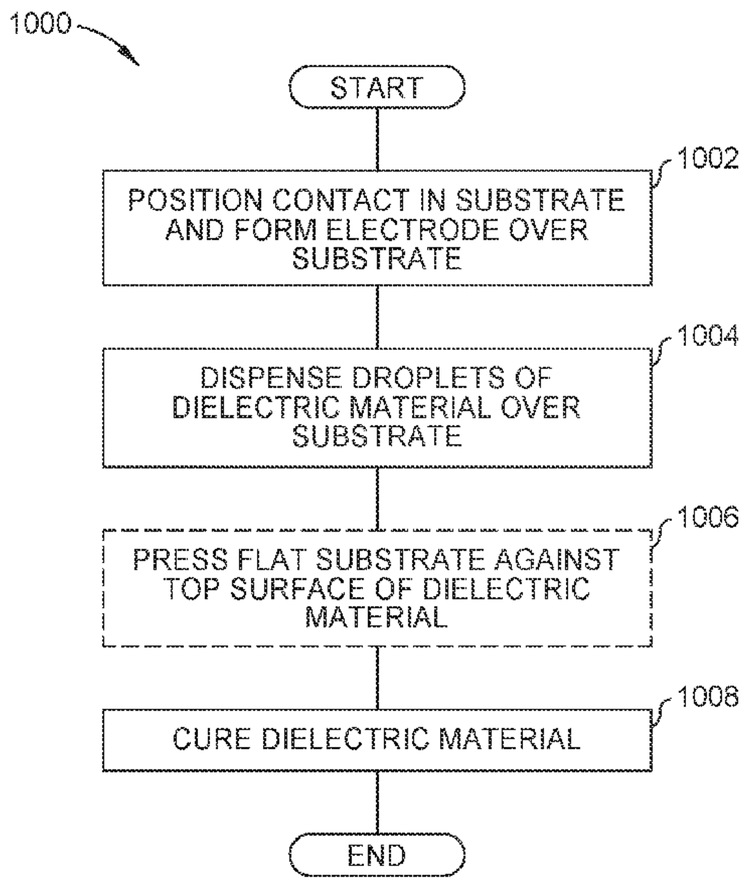
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(57) **ABSTRACT**

A method of forming a substrate carrier is provided. The method includes forming a first electrode over a first surface of a substrate, the first electrode arranged in a first pattern including a plurality of segments, wherein portions of the plurality of segments are spaced apart from each other by a plurality of gaps; and dispensing a plurality of droplets of a dielectric material over the substrate and into the plurality of gaps. The plurality of droplets includes a first droplet and a second droplet, the first droplet is dispensed onto a first location over the substrate, the second droplet is dispensed onto a second location over the substrate, a size of the first droplet is at least 10% larger than a size of the second droplet.

20 Claims, 4 Drawing Sheets



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B05D 3/06 (2006.01)
B05D 7/24 (2006.01)

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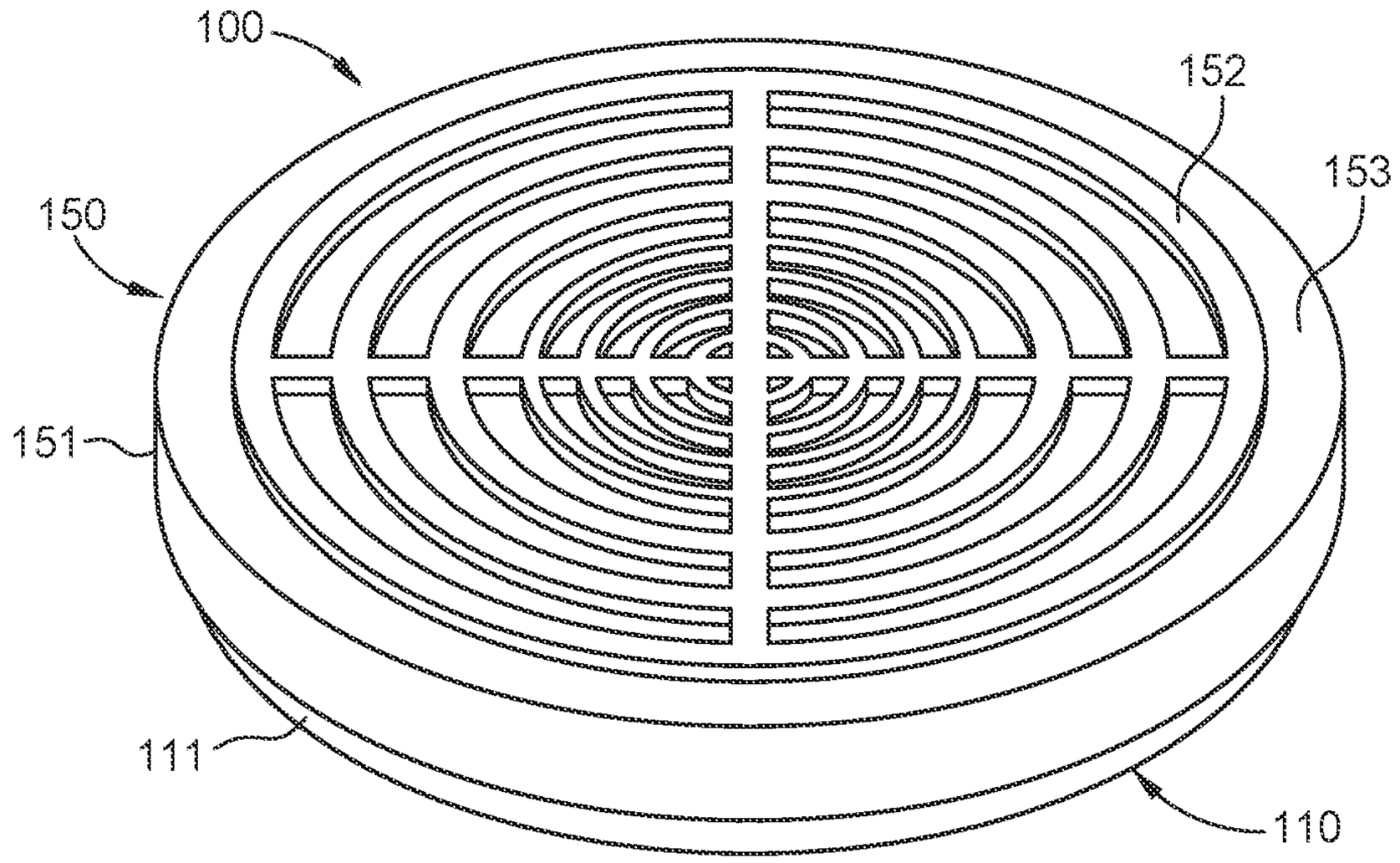

100
150
151
152
153
111
110

FIG. 1A

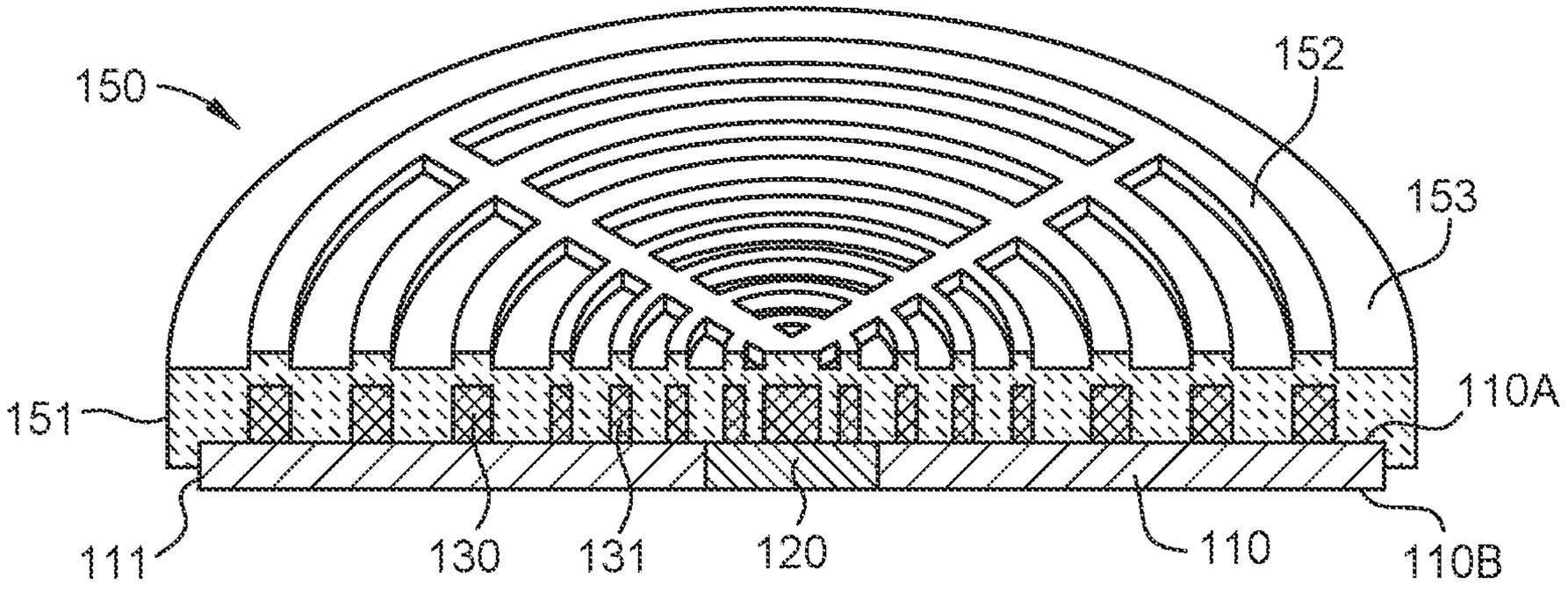

150
151
152
153
110A
111
130
131
120
110
110B

FIG. 1B

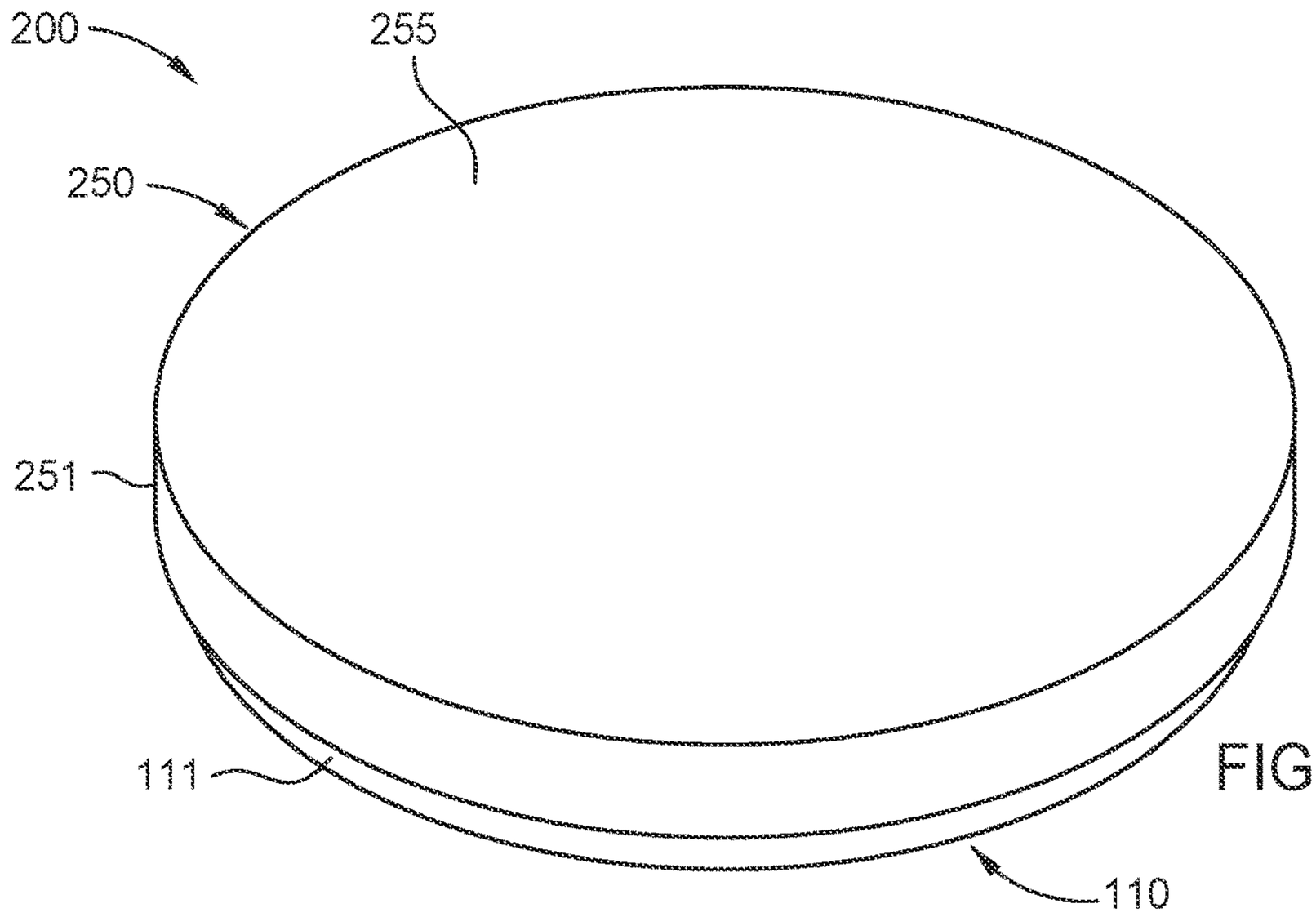


FIG. 2A

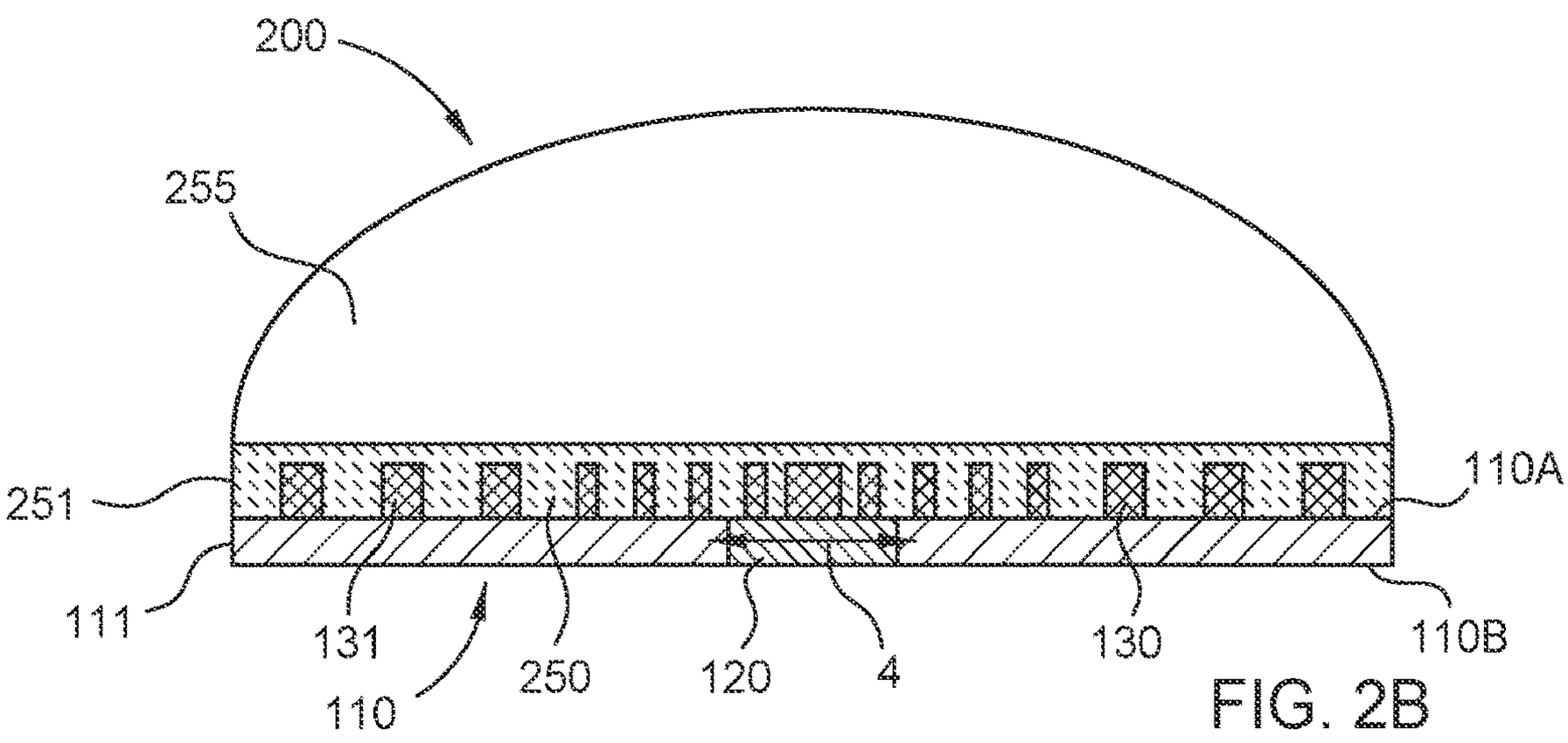


FIG. 2B

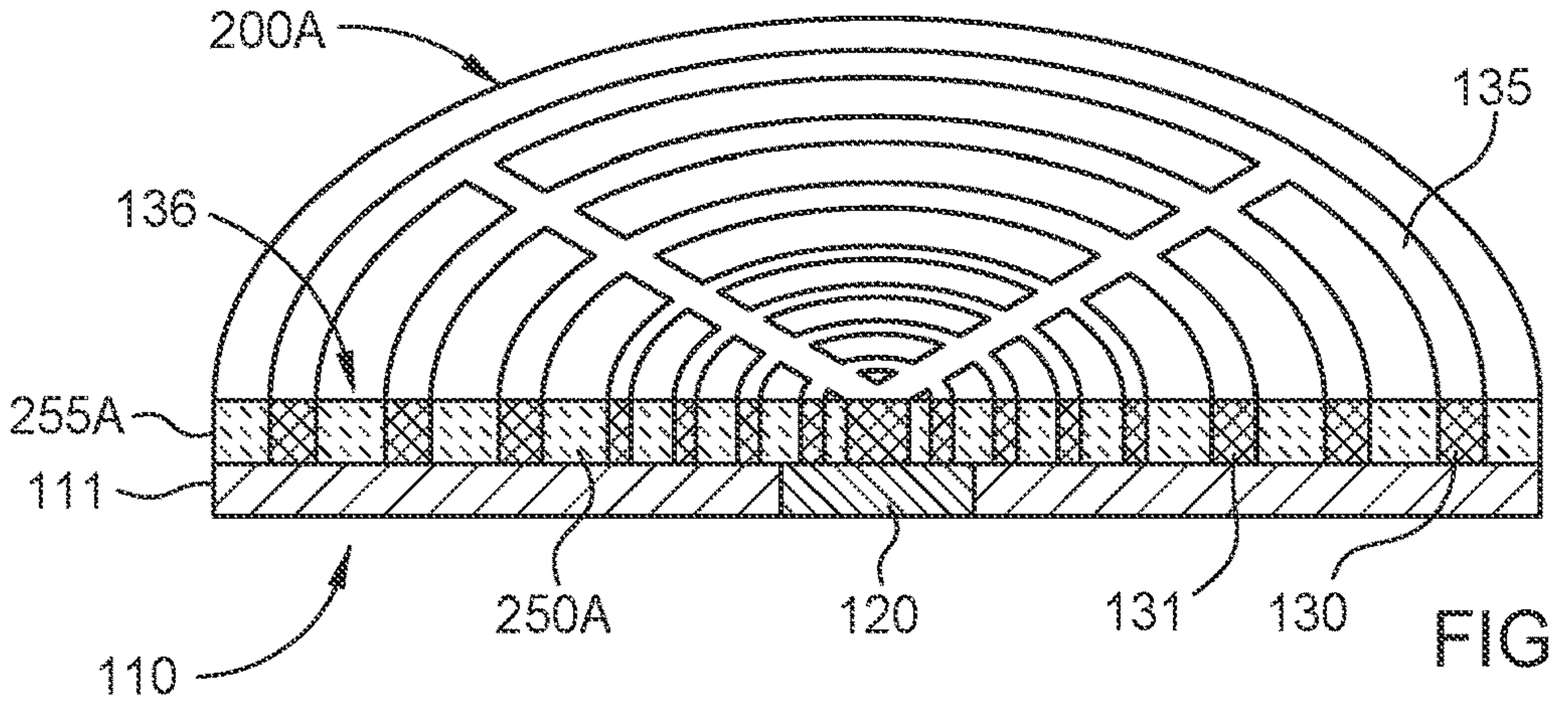


FIG. 2C

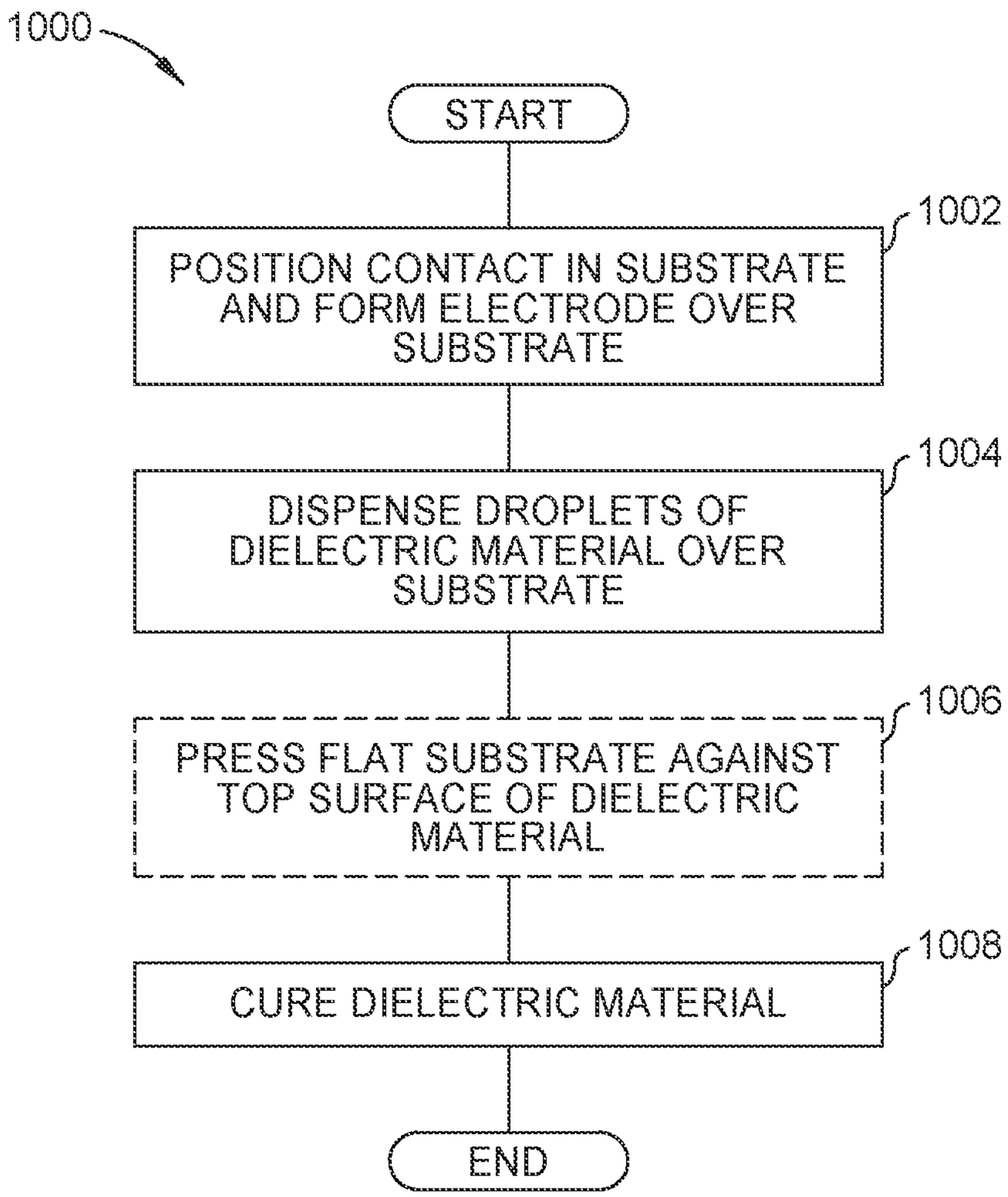

1000
START
POSITION CONTACT IN SUBSTRATE AND FORM ELECTRODE OVER SUBSTRATE
1002
DISPENSE DROPLETS OF DIELECTRIC MATERIAL OVER SUBSTRATE
1004
PRESS FLAT SUBSTRATE AGAINST TOP SURFACE OF DIELECTRIC MATERIAL
1006
CURE DIELECTRIC MATERIAL
1008
END

FIG. 3

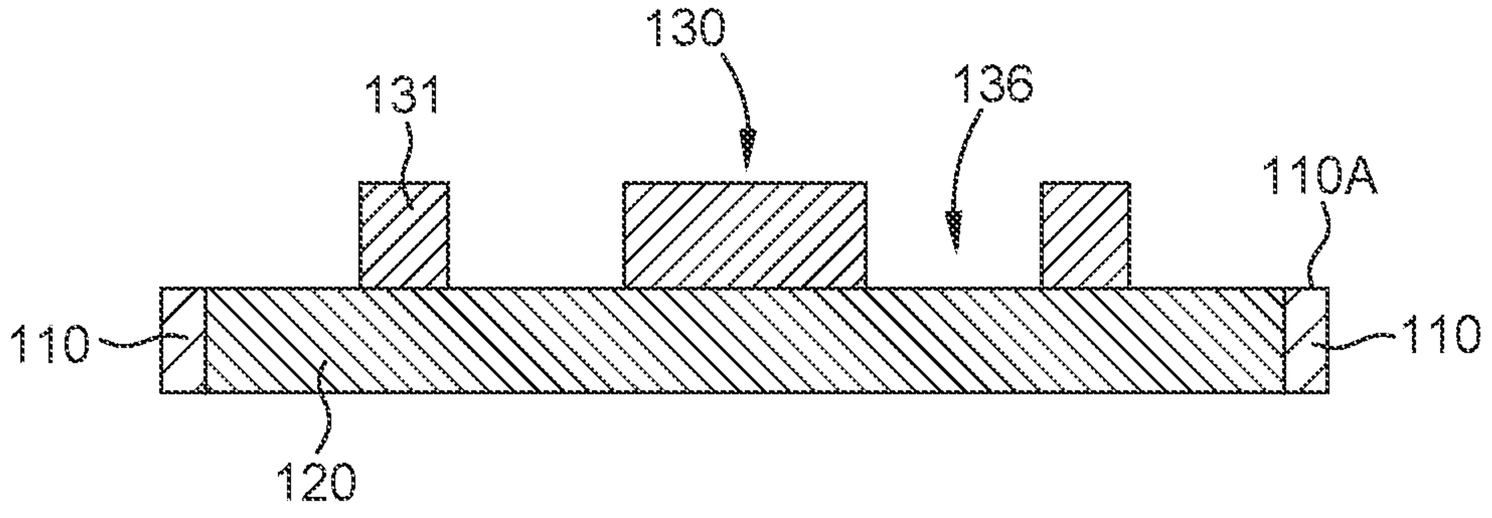


FIG. 4A

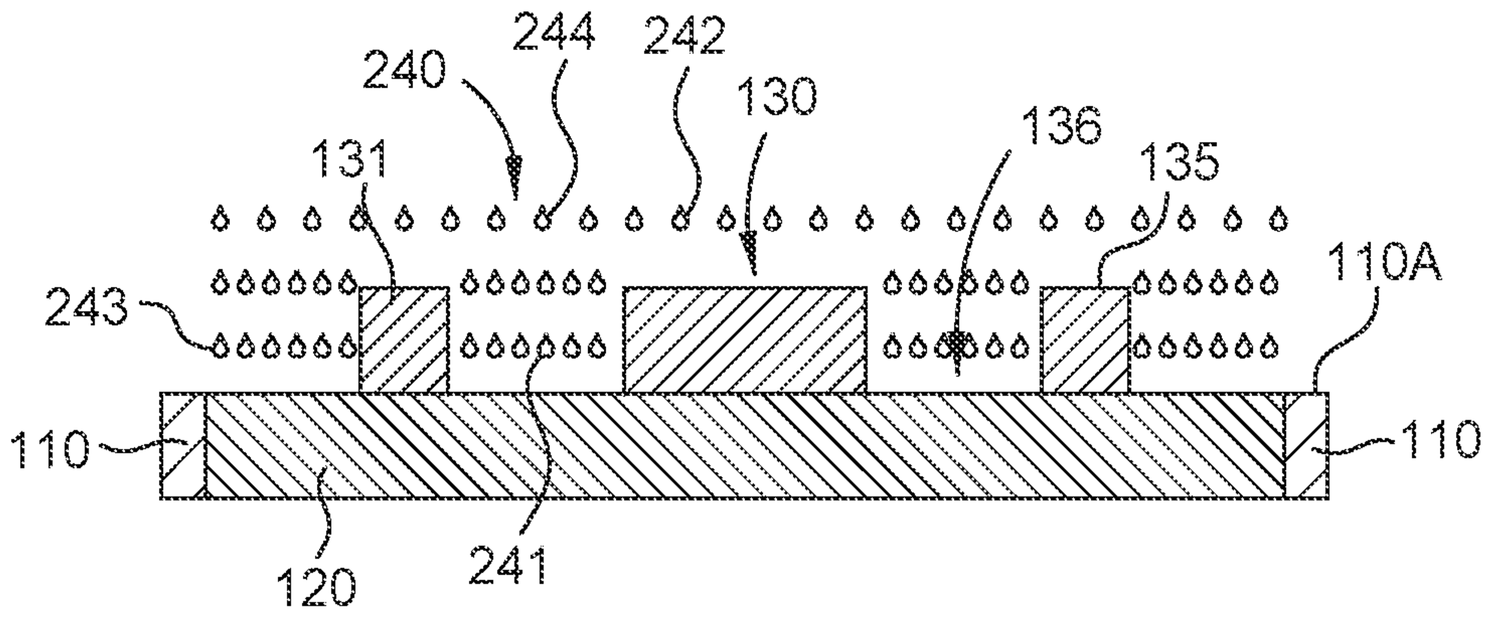


FIG. 4B

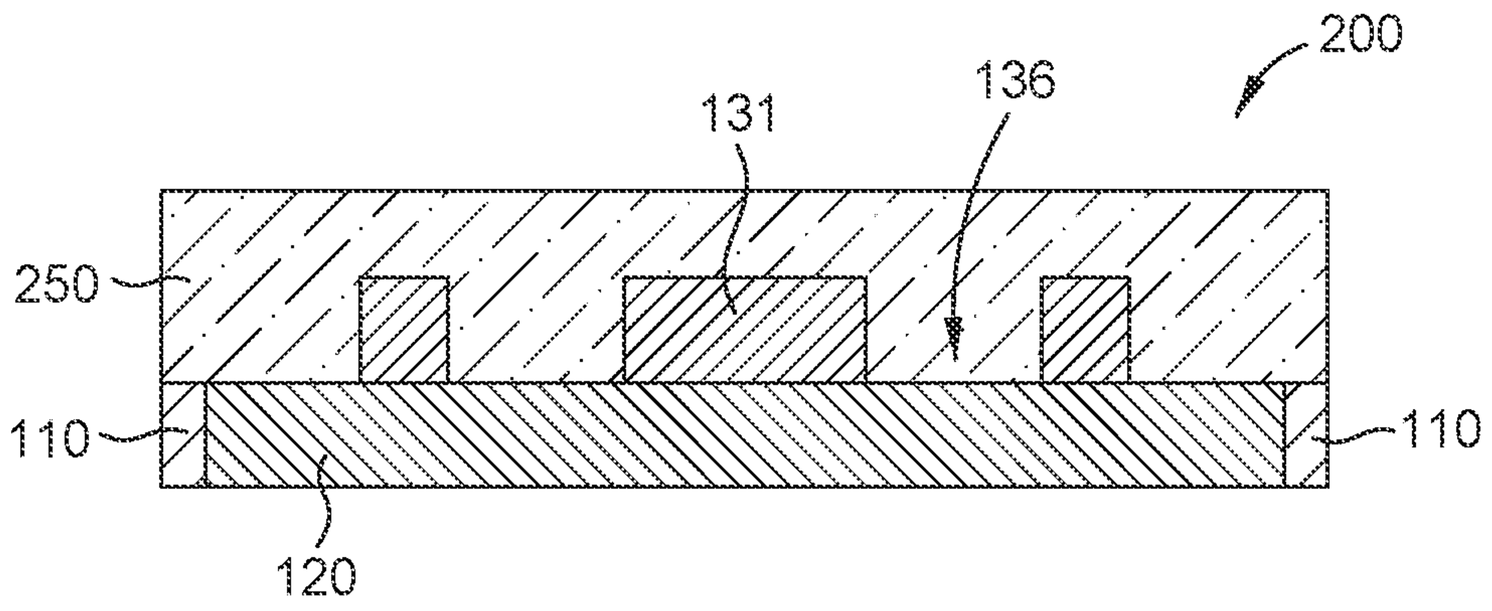


FIG. 4C

SUBSTRATE CARRIER IMPROVEMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Patent Application No. 63/357,983, filed on Jul. 1, 2022. The contents of this provisional patent application are herein incorporated by reference.

BACKGROUND

Embodiments of the present disclosure generally relate to substrate carriers. More specifically, embodiments described herein relate to methods of forming substrate carriers.

DESCRIPTION OF THE RELATED ART

Substrate carriers are often used to transport substrates (e.g., semiconductor substrates) between different equipment as different processes are performed on the substrates. The substrate being processed can rest on a surface (e.g., top surface) of the substrate carrier as the substrate is transported to or stored in the different equipment. The substrates being processed are often fragile, so the substrate carrier reduces the amount of stress on the substrate and contact between the substrate and different equipment, such as robotic end-effectors and substrate supports.

Some substrate carriers can include one or more electrodes that can be used to electrostatically clamp the substrate on the substrate carrier during the time period in which the substrate is on the substrate carrier. Generally, a dielectric layer is used to form the top surface of the substrate carrier. The dielectric layer allows the electric field from the electrical charge provided to the electrode of the substrate carrier to be coupled to the substrate, so that the substrate can be electrostatically clamped to the substrate carrier.

Although the dielectric layers conventionally used on substrate carriers can facilitate electrostatically clamping substrates to the substrate carriers, problems remain, such as dielectric layers with portions that can flake off and lead to additional particle generation as well as cracking of the dielectric layer. Accordingly, what is needed are improved substrate carriers and related methods for forming substrate carriers that include dielectric layers that do not lead to particle generation or cracking of the dielectric layer.

SUMMARY

In one embodiment, a method of forming a substrate carrier is provided. The method includes forming a first electrode over a first surface of a substrate, the first electrode arranged in a first pattern including a plurality of segments, wherein portions of the plurality of segments are spaced apart from each other by a plurality of gaps; and dispensing a plurality of droplets of a dielectric material over the substrate and into the plurality of gaps, wherein the plurality of droplets includes a first droplet and a second droplet, the first droplet is dispensed onto a first location over the substrate, the second droplet is dispensed onto a second location over the substrate, a size of the first droplet is at least 10% larger than a size of the second droplet.

In another embodiment, a method of forming a substrate carrier is provided. The method includes forming a first electrode over a first surface of a substrate, the first electrode arranged in a first pattern including a plurality of segments, wherein portions of the plurality of segments are spaced apart from each other by a plurality of gaps; and dispensing a plurality of droplets of a dielectric material over the substrate and into the plurality of gaps, wherein the plurality of droplets includes a first droplet and a second droplet, the first droplet is dispensed onto a first location over the substrate, the second droplet is dispensed onto a second location over the substrate, the first droplet includes a first plurality of dielectric particles, the second droplet includes a second plurality of dielectric particles, an average size of the first plurality of dielectric particles in the first droplet is at least 10% larger than an average size of the second plurality of dielectric particles in the second droplet.

In another embodiment, a method of forming a substrate carrier is provided. The method includes forming a first electrode over a first surface of a substrate, the first electrode arranged in a first pattern including a plurality of segments, wherein portions of the plurality of segments are spaced apart from each other by a plurality of gaps; and dispensing a plurality of droplets over the substrate and into the plurality of gaps to form a dielectric layer, wherein the plurality of droplets includes a first droplet and a second droplet, the first droplet is dispensed onto a first location over the substrate, the second droplet is dispensed onto a second location over the substrate, the first droplet is formed of a first dielectric mixture, and the second droplet is formed of a second dielectric mixture.

BRIEF DESCRIPTION OF THE DRAWINGS

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.

FIG. **1**A is a top view of a substrate carrier formed according to a conventional process.

FIG. **1**B is a side cross-sectional view of the substrate carrier of FIG. **1**A.

FIG. **2**A is a top view of a substrate carrier, according to one embodiment.

FIG. **2**B is a side cross-sectional view of the substrate carrier, according to one embodiment.

FIG. **2**C is a side cross-sectional view of an alternative substrate carrier, according to one embodiment.

FIG. **3** is a process flow diagram of a method of forming the substrate carrier shown in FIGS. **2**A and **2**B, according to one embodiment.

FIGS. **4**A-**4**C show partial cross-sectional views of the substrate carrier of FIGS. **2**A and **2**B at different stages of the method of FIG. **3**, according to one embodiment.

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

Embodiments of the present disclosure generally relate to substrate carriers and methods for forming substrate carriers. The substrate carriers can be used to transport substrates (e.g., semiconductor substrates), which are often fragile,

between different equipment as the substrates are processed. More specifically, embodiments described herein relate to substrate carriers that can electrostatically clamp a substrate as well as methods for forming the substrate carriers. In some embodiments, the methods can include forming a dielectric layer of the substrate carrier by dispensing droplets of dielectric material over the substrate of the substrate carrier, for example by using an inkjet process. In some embodiments, the dielectric material can include a mixture of dielectric particles (e.g., silicon oxide nanoparticles) and a curing agent, so that the dielectric layer can be cured after the droplets are dispensed. The droplets of the dielectric material can be provided with a high level of precision allowing different amounts, sizes, and/or different types of droplets to be applied at different locations over the substrate of the substrate carrier. This precision allows increased control over the uniformity and dimensions of the dielectric layer being formed compared to conventional processes used to form dielectric layers for substrate carriers, such as chemical vapor deposition (CVD), plasma-enhanced CVD, physical vapor deposition, or a spin-on-coating process.

FIG. **1**A is a top view of a substrate carrier **100** formed according to a conventional process. FIG. **1**B is a side cross-sectional view of the substrate carrier **100**.

The substrate carrier **100** includes a substrate **110**, an electrical contact **120**, an electrode **130**, and a dielectric layer **150**. The substrate **110** can include a first surface **110**A and a second surface **110**B. The electrical contact **120** is positioned within an opening in the substrate **110**. The electrode **130** and the dielectric layer **150** are formed over the first surface **110**A of the substrate **110**. The substrate **110** can be formed of silicon, glass, a ceramic material, or a metallic material. The contact **120** is formed of a conductive material, such as tungsten or aluminum.

The electrode **130** can be formed of a conductive material, such as titanium nitride. Some other materials that can be used for the electrode **130** can include copper, manganese, cobalt, aluminum, ruthenium, titanium, carbon as well as other conductive or semiconductive materials.

The electrode **130** includes a plurality of conductive segments **131** that are all electrically connected to each other and can be arranged in a pattern. An example of a ring-shaped pattern of the conductive segments **131** is shown in FIG. **2**C. The electrode **130** is electrically connected to the contact **120**. The plurality of conductive segments **131** can be used to distribute an electrical charge across the substrate carrier **100** when an electrical voltage is applied to the electrical contact **120**. The electrical charge can remain distributed across the conductive segments **131** for long durations (e.g., hours or days) after the voltage source is removed from the contact **120**. The distributed electrical charge can be used to clamp a substrate (not shown) on the substrate carrier **100**. The substrate can remain clamped on the substrate carrier **100** as long as the electrode **130** remains charged.

The dielectric layer **150** generally includes a dielectric material, such as an oxide (e.g., silicon oxide), a nitride (e.g., silicon nitride), or rubber. The dielectric layer **150** is generally formed using a spin-on-coating process or a deposition process, such as chemical vapor deposition or physical vapor deposition. Although these processes can be used for forming the dielectric layer **150**, these processes result in a nonplanar top surface **153** of the dielectric layer **150** and an edge **151** of the dielectric layer **150** that overhangs an edge **111** of the substrate **110**.

The nonplanar top surface **153** of the dielectric layer **150** can include a plurality of elevated portions **152** that overlie the plurality of conductive segments **131** of the electrode **130**. The plurality of elevated portions **152** are raised relative to other portions of the top surface **153** of the dielectric layer **150**. The elevated portions **152** of the dielectric layer **150** can reduce the electrostatic clamping force of the substrate carrier **100** when an electrical charge is provided to the electrode **130** due to the increased distance between the substrate (not shown) and the non-elevated portions of the top surface **153** of the dielectric layer **150**. A planarization process (e.g., chemical mechanical polishing (CMP)) or an etching process can be performed to remove the elevated portions **152** to increase the electrostatic clamping force of the substrate carrier **100**. However, these additional processes can be costly and time-consuming, and thus should be avoided if possible.

The edge **151** of the dielectric layer **150** overhangs the edge **111** of the substrate **110**. This overhang of the edge **151** can lead to flaking and particle generation by the substrate carrier **100**, which can lead to reduced product yield and increased downtime for cleaning procedures to remove the particles. The overhanging edge **151** is also more prone to cracking and scratching, which can reduce the useful life of the substrate carrier **100**. To address these problems associated with the substrate carrier **100**, a new substrate carrier **200** as described below is proposed.

FIG. **2**A is a top view of a substrate carrier **200**, according to one embodiment. FIG. **2**B is a side cross-sectional view of the substrate carrier **200**, according to one embodiment.

The substrate carrier **200** is similar to the substrate carrier **100** described above except that the substrate carrier **200** includes a dielectric layer **250** that is different than the dielectric layer **150** of the substrate carrier **100**. The dielectric layer **250** can be formed by a process (e.g., an inkjet process) that dispenses a plurality of droplets of dielectric material over the substrate **110** as well as between and over the conductive segments **131** of the electrode **130**. The plurality of droplets of dielectric material can be dispensed over the substrate **110** with high precision allowing the dielectric layer **250** to be formed within targeted dimensions without requiring any additional removal processes, such as CMP or an etching process. This high level of precision enables an edge **251** of the dielectric layer **250** to be aligned with the edge **111** of the substrate **110**, which prevents the problems described above associated with the overhanging edge **151** from occurring, such as cracking, scratching, flaking and particle generation. Additionally, due to the high level of precision, the dielectric layer **250** does not include the elevated portions **152** of the dielectric layer **150** described above. For example, a top surface **255** of the dielectric layer **250** is shown as substantially flat. Used herein, substantially flat can refer to a surface that varies in elevation from 0.5 nm to about 500 micron, such as from about 1 nm to about 100 micron.

The dielectric layer **250** can be formed with the edge **251** aligned with the edge **111** of the substrate and without the elevated portions **152** of the dielectric layer **150** because the dielectric layer **250** is formed using a process, such as an inkjet printing process, that varies how the material of the dielectric layer **250** is provided over different portions of the substrate **110**. For example, when an inkjet printing process is used, the quantity of droplets, the size of droplets, the size of dielectric particles in the droplets, the distance between consecutive droplets (also referred to as pitch), the shape of the droplets, and/or the materials included in the droplets can be varied across the substrate **110** or from substrate to substrate. In some embodiments, the quantity of similarly sized droplets, the size of droplets, the size of dielectric

particles inside the droplets, and/or materials included in the droplets can be varied for the gaps between the conductive segments **131** relative to the droplets dispensed over areas directly overlying the conductive segments **131** or for areas near the edge **111** of the substrate **110**.

FIG. **2**C is a side cross-sectional view of an alternative substrate carrier **200**A, according to one embodiment. The substrate carrier **200**A is the same as the substrate carrier **200** described above except that the substrate carrier **200**A includes a dielectric layer **250**A that is different than the dielectric layer **250** included in the substrate carrier **200**. The dielectric layer **250**A includes a top surface **255**A that is at a same elevation as a top surface **135** of the conductive segments **131** of the electrode **130**. Thus, the top surface **135** of the conductive segments **131** can be exposed when a substrate (not shown) is clamped to the substrate carrier **200**A. Forming the substrate carrier **200**A would not be possible using conventional techniques (e.g., CVD, PVD, or spin-on-coating processes) for forming the dielectric layer of a substrate carrier without removal of a large amount of dielectric material down to the top surface **135** of the conductive segments **131**.

FIG. **3** is a process flow diagram of a method **1000** of forming the substrate carrier **200** shown in FIGS. **2**A and **2**B, according to one embodiment. FIGS. **4**A-**4**C show partial cross-sectional views of the substrate carrier **200** at different stages of the method **1000**, according to one embodiment. The views in FIGS. **4**A-**4**C are taken along section line **4** from FIG. **2**B. The method **1000** begins at block **1002**.

At block **1002**, with reference to FIG. **4**A, the contact **120** is positioned in the substrate **110**, and the electrode **130** is formed over the substrate **110**. In some embodiments, the contact **120** can be positioned in an opening in the substrate **110** and attached to the substrate **110** using a soldering, brazing, or adhesive process. The electrode **130** can be formed over the substrate **110** using a PVD process, such as a PVD process using a mask to control the deposition of the material used to form the electrode **130**. The electrode **130** can be formed of the conductive segments **131**. Portions of the conductive segments **131** of the electrode **130** can be spaced apart from each other by a plurality of gaps **136**. The spacing apart of different portions of the conductive segments **131** is also shown in the top view of the substrate carrier **200**A in FIG. **2**C.

At block **1004**, with reference to FIG. **4**B, a plurality of droplets of dielectric material **240** are dispensed over the substrate **110**. The plurality of droplets of dielectric material **240** can be dispensed over the substrate **110**, over the contact **120**, over the conductive segments **131**, and into the gaps **136** between the conductive segments **131**. Although the droplets of dielectric material **240** are shown as being dispensed simultaneously over the entire portion of the substrate carrier shown in FIG. **4**B, this is for ease of illustration only, and in many instances the droplets of dielectric material **240** can be dispensed in a slower manner, such as one droplet at a time.

The dielectric material **240** can be a mixture that includes a plurality of components, such as dielectric particles, one or more curing agents, one or more solvents as wells as one or more binders or other additives.

In some embodiments, the dielectric particles can include dielectric nanoparticles (i.e., particles having a size from about 1 nm to about 100 nm) or larger dielectric particles, such as particles having a size from about 100 nm to about 10 micron, such as from about 500 nm to about 1 micron, but in some embodiments smaller (e.g., 0.5 nm) or even larger dielectric particles (e.g., 20 micron) can also be used. The dielectric particles in the droplets can be formed of one or more dielectric materials, such as silicon oxide, titanium oxide, zinc oxide, zirconium oxide, niobium oxide, hafnium oxide, vanadium oxide, lead oxide, tantalum oxide, and rubber.

In some embodiments, the dielectric material **240** can include one or more curing agents, such as an ultraviolet curing agent or other radiation-sensitive curing agent, a thermal curing agent, or a chemical curing agent. Some additional materials in the dielectric material **240** can include acrylate or methacrylate monomers, photoinitiators, epoxy, polymers (e.g., polydimethylsiloxane, polystyrene, polyether, polyester, polycarbonate, polyurethane, and derivatives of each), or curing agents, such as an amine, anhydride, thiol, amide, or urea-based curing agent or a photoacid generator curing agent.

Solvents in the dielectric material **240** can include but are not limited to an alcohol, ester, ether, or siloxane solvent. Additives in the dielectric material **240** can include additives for adjusting the surface tension or viscosity of the dielectric material **240**, which is dispensed from a nozzle or other component using inkjet equipment (not shown).

In FIG. **4**B, four individual droplets **241**-**244** of dielectric material **240** are identified. Each of the locations on which the droplets are dispensed can be referred to as a location over the substrate **110**. A first droplet **241** can be dispensed onto the electrical contact **120** in one of the plurality of gaps **136**. A second droplet **242** is dispensed onto one of the conductive segments **131** of the electrode **130**. A third droplet **243** is dispensed onto the first surface **110**A of the substrate **110**. A fourth droplet **244** is dispensed onto a last row of dielectric material **240**. The material of the fourth droplet **244** can form a top surface of the dielectric layer **250**. Although the droplets **241**-**244** are shown as identical, this is for ease of illustration, and the droplets **241**-**244** can be different from each other as described below. Droplets dispensed over locations that only spaced apart horizontally, such as droplets **241**, **243** or droplets **244**, **242** can be different in all of the ways described below. Furthermore, droplets dispensed over locations that directly underlie of overlie each other, such as droplets **241**, **244** can also be different from each other in all of the ways described below.

The dispensing of the dielectric material can vary over different portions of the substrate **110**. For example, a higher quantity (e.g., 1% more, 10% more, 50%, 100% more, etc.) of droplets of dielectric material **240** can be provided into the gaps **136** between the conductive segments **131** than the quantity of droplets provided over areas directly overlying the conductive segments **131**. The quantity of droplets can vary in a horizontal direction (i.e., parallel to the first surface **110**A of the substrate **110**) or in a vertical direction (i.e., perpendicular to the first surface **110**A of the substrate **110**, which is also referred to as the thickness direction of the dielectric layer being formed). In one embodiment, a higher quantity of smaller droplets can be used for the top row of droplets to increase the likelihood of obtaining the flat top surface **255** of the dielectric layer **250**.

In some embodiments, the size of droplets can vary over different portions of the substrate **110**. For example, in one embodiment, droplets having a larger droplet volume (e.g., 1% larger, 10% larger, 50% larger, 100% larger, 1000% larger, etc.) can be provided on the areas directly overlying the conductive segments **131** (e.g., droplet **242**) compared to the size of droplets dispensed in the gaps **136** (e.g., droplet **241**) or vice versa. Furthermore, the size of droplets can vary in a thickness direction of the dielectric layer being formed from the droplets of dielectric material **240**. For example,

smaller droplets can be used in the gaps **136** (e.g., droplet **241**) compared to the larger size (e.g., 1% larger, 10% larger, 50% larger, 100% larger, 1000% larger, etc.) of droplets overlying the gaps **136** (e.g., droplet **244**), but at an elevation above the top surface **135** of the conductive segments **131**. In another embodiment, smaller droplets can be used for the droplets that form the top row of the dielectric layer **250** (e.g., droplets **242** and **244**) to increase the likelihood of obtaining a flat top surface of the dielectric layer **250**. Smaller droplets can also be used for the droplets that are dispensed in areas near the edge **111** of the substrate **110** (e.g., droplet **243**) to increase the likelihood of obtaining the edge **251** of the dielectric layer **250** that is aligned with the edge **111** of the substrate **110**. In some embodiments, smaller droplets with a reduced pitch (i.e., horizontal distance between neighboring droplets) can be used to form the outer edge **251** of the dielectric layer **250** and the top surface **255** of the dielectric layer.

In some embodiments, an average size (e.g., a volume, an area, or a length) of the dielectric particles (e.g., nanoparticles) in the droplets of dielectric material **240** dispensed over a first location of the substrate **110** can be larger (e.g., at least 1% larger, 10% larger, 50% larger, 100% larger, 1000% larger, etc.) than an average size of particles dispensed over a second location of the substrate **110**. In some embodiments, the size of dielectric particles in the droplets can be varied for the same reasons provided above for the size (e.g., volume) of the droplets, including but not limited to using smaller dielectric particles for the droplets forming the top surface or edge of the dielectric layer **250** relative to the size of the dielectric particles in the other droplets.

In some embodiments, the components in the mixture that forms the dielectric material can vary across different locations over the substrate **110** or at different thickness locations over the substrate. In one embodiment, dielectric particles formed of a first material are dispensed first at locations near the substrate **110** while dielectric particles formed of a second material are dispensed at locations closer to the top surface of the dielectric layer **250** being formed. In another embodiment, the dielectric particles and/or other material(s) can be modified (e.g., the viscosity of the droplets is modified) for droplets near the top surface (e.g., droplet **244**) or edge (e.g., droplet **243**) of the dielectric layer **250** relative to droplets away from these locations (e.g., droplet **241**) to increase the likelihood of obtaining the flat top surface **255** of the dielectric layer **250** and to increase the likelihood of obtaining the edge **251** of the dielectric layer **250** that is aligned with the edge **111** of the substrate **110**.

At block **1006**, a flat object, such as flat substrate can optionally be pressed against the dielectric material **240** before the dielectric material is cured to further improve the flatness of the top surface **255** of the dielectric layer **250**.

At block **1008**, the dielectric material **240** is cured to form the dielectric layer **250**. The curing process depends on the curing agent used in the dielectric material. For example, the curing process can include an ultraviolet curing process, a thermal curing process, or a chemical curing process. In some embodiments, the droplets having any of the differences described above (e.g., size, size of particles in the droplets, materials in the droplets) can be cured simultaneously.

After the curing process, no additional removal processes, such as a CMP or etching process are needed, for example to remove the elevated portions **152** of the substrate carrier **100** shown in FIG. **1**A because the substrate carrier **200** does not include these elevated portions. Furthermore, the inkjet process described above also prevents an overhang, such as the overhanging edge **151** of the substrate carrier **100** shown in FIG. **1**B, from being formed, which enables the problems associated with the overhanging edge **151** to be avoided, such as cracking, flaking, scratching, and particle generation.

While the foregoing is directed to examples of the present disclosure, other and further examples of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

What is claimed is:

1. A method of forming a substrate carrier comprising:

forming a first electrode over a first surface of a substrate, the first electrode arranged in a first pattern including a plurality of segments, wherein portions of the plurality of segments are spaced apart from each other by a plurality of gaps; and

dispensing a plurality of droplets of a dielectric material over the substrate and into the plurality of gaps, wherein

the plurality of droplets includes a first droplet and a second droplet,

the first droplet is dispensed onto a first location over the substrate,

the second droplet is dispensed onto a second location over the substrate, and

a size of the first droplet is at least 10% larger than a size of the second droplet.

2. The method of claim **1**, wherein the first location over the substrate is spaced apart from the second location over the substrate in a direction that is parallel to the first surface of the substrate.

3. The method of claim **1**, wherein the first location over the substrate directly overlies or directly underlies the second location over the substrate.

4. The method of claim **1**, wherein each droplet of the dielectric material includes a plurality of dielectric nanoparticles.

5. The method of claim **4**, wherein the plurality of dielectric nanoparticles includes one or more nanoparticles formed of silicon oxide, titanium oxide, zinc oxide, zirconium oxide, niobium oxide, hafnium oxide, vanadium oxide, lead oxide, tantalum oxide, and rubber.

6. The method of claim **1**, wherein the size of the first droplet is at least 50% larger than the size of the second droplet.

7. The method of claim **1**, further comprising curing the dielectric material.

8. A method of forming a substrate carrier comprising:

forming a first electrode over a first surface of a substrate, the first electrode arranged in a first pattern including a plurality of segments, wherein portions of the plurality of segments are spaced apart from each other by a plurality of gaps; and

dispensing a plurality of droplets of a dielectric material over the substrate and into the plurality of gaps, wherein

the plurality of droplets includes a first droplet and a second droplet,

the first droplet is dispensed onto a first location over the substrate,

the second droplet is dispensed onto a second location over the substrate,

the first droplet includes a first plurality of dielectric particles,

the second droplet includes a second plurality of dielectric particles, and

an average size of the first plurality of dielectric particles in the first droplet is at least 10% larger than an average size of the second plurality of dielectric particles in the second droplet.

9. The method of claim **8**, wherein the first location over the substrate is spaced apart from the second location over the substrate in a direction that is parallel to the first surface of the substrate.

10. The method of claim **8**, wherein the first location over the substrate directly overlies or directly underlies the second location over the substrate.

11. The method of claim **8**, wherein the first and second plurality of dielectric particles each include one or more dielectric nanoparticles formed of silicon oxide, titanium oxide, zinc oxide, zirconium oxide, niobium oxide, hafnium oxide, vanadium oxide, lead oxide, tantalum oxide, and rubber.

12. The method of claim **8**, wherein the average size of the first plurality of dielectric particles in the first droplet is at least 50% larger than the average size of the second plurality of dielectric particles in the second droplet.

13. The method of claim **8**, further comprising curing the dielectric material.

14. A method of forming a substrate carrier comprising:

forming a first electrode over a first surface of a substrate, the first electrode arranged in a first pattern including a plurality of segments, wherein portions of the plurality of segments are spaced apart from each other by a plurality of gaps; and

dispensing a plurality of droplets over the substrate and into the plurality of gaps to form a dielectric layer, wherein

the plurality of droplets includes a first droplet and a second droplet,

the first droplet is dispensed onto a first location over the substrate,

the second droplet is dispensed onto a second location over the substrate,

the first droplet is formed of a first dielectric mixture, and

the second droplet is formed of a second dielectric mixture.

15. The method of claim **14**, wherein

the first dielectric mixture includes a first plurality of dielectric nanoparticles formed of a first dielectric material, and

the second dielectric mixture includes a second plurality of dielectric nanoparticles formed of a second dielectric material.

16. The method of claim **15**, wherein a size of the first droplet is at least 50% larger than a size of the second droplet.

17. The method of claim **15**, an average size of the first plurality of dielectric nanoparticles in the first droplet is at least 50% larger than an average size of the second plurality of nanodielectric particles in the second droplet.

18. The method of claim **14**, wherein the first location over the substrate is spaced apart from the second location over the substrate in a direction that is parallel to the first surface of the substrate.

19. The method of claim **14**, wherein the first location over the substrate directly overlies or directly underlies the second location over the substrate.

20. The method of claim **14**, further comprising curing the first droplet and the second droplet simultaneously.

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