# OZONE GENERATOR

## Field of the Invention

**[0001]** The currently described invention relates to ozone generators and methods for generating ozone.

## Background

**[0002]** Prior art ozone generators are incapable of producing useful quantities of ozone without a dopant (e.g., nitrogen) for extended periods of time. In addition, the ozone generators also are unable to operate at very low temperatures which are necessary to produce high concentrations of ozone.

**[0003]** A need therefore exists for improved ozone generators and methods for generating ozone.

## Summary

**[0004]** Embodiments of the invention involve ozone generators and methods for producing high concentrations of high purity ozone with systems that have reduced shear stress between the components of the ozone generator cells. These systems are able to operate at very low temperatures and have improved serviceability relative to conventional systems.

**[0004a]** In one aspect, there is provided an ozone generator comprising: an ozone generator cell comprising: a high voltage electrode layer having a first side and a second side opposing the first side, a first dielectric layer having a first side and a second side opposing the first side, and a second dielectric layer having a first side and a second side opposing the first side, the second side of the first dielectric layer disposed on the first side of the high voltage electrode layer and the first side of the second dielectric layer disposed on the second side of the high voltage electrode layer, a first low voltage electrode layer having a first side and a second side opposing the first side, and a second low voltage electrode layer having a first side and a second side opposing the first side, the second side of the first low voltage electrode layer disposed over the first side of the first dielectric layer and the first side of the second low voltage electrode layer disposed over the second side of the second dielectric layer, two discharge regions, a first discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the first dielectric layer disposed on the first side of the high voltage electrode layer, and the second side of the first low voltage electrode layer disposed on the first side of the first dielectric layer, a second discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the second dielectric layer disposed on the second side of the high voltage electrode layer, and the first side of the second low voltage electrode layer disposed on the second side of the second dielectric layer, and a first thermally conductive plate having a first side and a second side opposing the first side, and a second thermally conductive plate having a first side and a second side opposing the first side, the second side of the first thermally conductive plate disposed over the first side of the first low voltage electrode layer and the first side of the second thermally conductive plate disposed over the second side of the second low voltage electrode layer, wherein the two thermally conductive plates maintain contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located therebetween in the absence of a bonding agent; a base plate over which the ozone generator cell is positioned; and a spring-loaded clamp plate coupled to the base plate such that the ozone generator cell is disposed between the base plate and the spring-loaded clamp plate, such that the coupled base plate and spring-loaded clamp plate apply pressure to the ozone generator cell to hold the layers of the ozone generator cell together, wherein the two dielectric layers, the two low voltage electrode layers, and the high voltage electrode layer are all fabricated using non-aluminum containing materials.

**[0004b]** In another aspect, there is provided a method for fabricating an ozone generator cell, the method comprising: locating a second side of a first dielectric layer on a first side of a high voltage electrode layer; locating a first side of a second dielectric layer on a second, opposite side of the high voltage electrode layer; locating a second side of a first low voltage electrode layer over a first side of the first dielectric layer to define a first discharge region by combination of the high voltage electrode layer, the first dielectric layer and the first

low voltage electrode layer; locating a first side of a second low voltage electrode layer over a second side of the second dielectric layer to define a second discharge region by combination of the high voltage electrode layer, the second dielectric layer and the second low voltage electrode layer; locating a first thermally conductive plate over a first side of the first low voltage electrode layer; locating a second thermally conductive plate over the second side of the second low voltage electrode layer; locating a base plate over the second thermally conductive plate; locating a spring-loaded clamp plate over the first thermally conductive plate; and coupling the spring-loaded clamp plate to the base plate, the coupled spring-loaded clamp plate and base plate applying pressure to the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located between the first and second thermally conductive plates to maintain contact between the layers located therebetween in the absence of a bonding agent.

**[0004c]** In another aspect, there is provided an ozone generator comprising: an ozone generator cell comprising: a high voltage electrode layer having a first side and a second side opposing the first side, a first dielectric layer having a first side and a second side opposing the first side, and a second dielectric layer having a first side and a second side opposing the first side, the second side of the first dielectric layer disposed on the first side of the high voltage electrode layer and the first side of the second dielectric layer disposed on the second side of the high voltage electrode layer, a first low voltage electrode layer comprising tungsten and having a first side and a second side opposing the first side, and a second low voltage electrode layer comprising tungsten and having a first side and a second side opposing the first side, the second side of the first low voltage electrode layer disposed over the first side of the first dielectric layer and the first side of the second low voltage electrode layer disposed over the second side of the second dielectric layer, two discharge regions, a first discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the first dielectric layer disposed on the first side of the high voltage electrode layer, and the second side of the first low voltage electrode layer disposed on the first side of the first dielectric layer, a second discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the second dielectric layer disposed on the second side of the high voltage electrode layer, and the first side of the second low voltage electrode layer disposed on the second side of the second dielectric layer, and a first thermally conductive plate having a first side and a second side opposing the first side, and a second thermally conductive plate having a first side and a second side opposing the first side, the second side of the first thermally conductive plate disposed over the first side of the first low voltage electrode layer and the first side of the second thermally conductive plate disposed over the second side of the second low voltage electrode layer, wherein the two thermally conductive plates maintain contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low

voltage electrode layer located therebetween in the absence of a bonding agent; a base plate over which the ozone generator cell is positioned; and a spring-loaded clamp late coupled to the base plate such that the generator cell is disposed between the base plate and the spring-loaded clamp plate, such that the coupled base plate and spring-loaded clamp plate apply pressure to the ozone generator cell to maintain the contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer and the second low voltage electrode layer located therebetween in the absence of a bonding agent.

**[0004d]** In another aspect, there is provided a high concentration ozone generator comprising: an ozone generator cell comprising: a high voltage electrode layer fabricated using non-aluminum containing materials having a first side and a second side opposing the first side, a first dielectric layer having a first side and a second side opposing the first side, and a second dielectric layer having a first side and a second side opposing the first side, the second side of the first dielectric layer disposed on the first side of the high voltage electrode layer and the first side of the second dielectric layer disposed on the second side of the high voltage electrode layer, a first low voltage electrode layer having a first side and a second side opposing the first side, and a second low voltage electrode layer having a first side and a second side opposing the first side, the second side of the first low voltage electrode layer disposed over the first side of the first dielectric layer and the first side of the second low voltage electrode layer disposed over the second side of the second dielectric layer, two discharge regions lacking aluminum containing materials, a first discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the first dielectric layer disposed on the first side of the high voltage electrode layer, and the second side of the first low voltage electrode layer disposed on the first side of the first dielectric layer, a second discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the second dielectric layer disposed on the second side of the high voltage electrode layer, and the first side of the second low voltage electrode layer disposed on the second side of the second dielectric layer, and a first thermally conductive plate having a first side and a second side opposing the first side, and a second thermally conductive plate having a first side and a second side opposing the first side, the second side of the first thermally conductive plate disposed over the first side of the first low voltage electrode layer and the first side of the second thermally conductive plate disposed over the second side of the second low voltage electrode layer, wherein the two thermally conductive plates maintain contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located therebetween in the absence of a bonding agent to

reduce the shear stresses in the ozone generator cell; a base plate over which the ozone generator cell is positioned; and a spring-loaded clamp plate coupled to the base plate such that the ozone generator cell is disposed between the base plate and the spring-loaded clamp plate, such that the coupled base plate and spring-loaded clamp plate apply pressure to the ozone generator cell to maintain the contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located therebetween in the absence of a bonding agent to reduce the shear stresses in the ozone generator cell.

**[0005]** Herein disclosed is ~~The invention, in one aspect, features~~ an ozone generator cell that includes a high voltage electrode layer and two dielectric layers. The first dielectric layer is disposed on a first side of the high voltage electrode layer and the second dielectric layer is disposed on the second, opposite side of the high voltage electrode layer. The ozone generator cell also includes two low voltage electrode layers. One low voltage electrode layer is disposed over each of the two dielectric layers. The ozone generator cell also includes two discharge regions, the first discharge region defined, in part, by the high voltage electrode layer, the dielectric layer disposed on the first side of the high voltage electrode layer, and the low voltage electrode layer disposed on the first side of the high voltage electrode layer, the second discharge region defined, in part, by the high voltage electrode layer, the dielectric layer is disposed on the second side of the high voltage electrode layer, and the low voltage electrode layer is disposed on the second side of the high voltage electrode layer. The ozone generator cell also includes two thermally

conductive plates, the first thermally conductive plate in contact with the low voltage electrode layer on the first side of the high voltage electrode layer, and the second thermally conductive plate in contact with the low voltage electrode layer on the second side of the high voltage electrode layer, wherein the two thermally conductive plates maintain contact between the layers located therebetween in the absence of a bonding agent.

**[0006]** In some embodiments, maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer. In some embodiments, the reduced thickness produces an increased capacitance between the low voltage electrode layers and the high voltage electrode layer. In some embodiments, the dielectric layers, the low voltage electrode layers, and the high voltage electrode layer are fabricated using non-aluminum containing materials.

**[0007]** In some embodiments, the ozone generator cell includes spacer shims protruding from a surface of each low voltage electrode layer towards a surface of a dielectric layer. In some embodiments, the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer, and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage electrode layers and the second side of the high voltage electrode layer. In some embodiments, the spacer shims are integral portions of the low voltage electrode layers or separate components sandwiched between the dielectric layers and the low voltage electrode layers.

**[0008]** Herein disclosed is~~The invention, in another aspect, features~~ a method for fabricating an ozone generator cell. The method includes locating a first dielectric layer on a first side of a high voltage electrode layer and locating a second dielectric layer on a second, opposite side of the high voltage electrode layer. The method also includes locating a first low voltage electrode layer over the first dielectric layer to define a first discharge region by combination of the high voltage electrode layer, the first dielectric layer and the first low voltage electrode layer. The method also includes locating a second low voltage electrode layer over the second dielectric layer to define a second discharge region by combination of the high voltage electrode layer, the second dielectric layer and the second low voltage

**[0013]** Herein disclosed is~~The invention, in another aspect, features~~ an ozone generator cell that includes a high voltage electrode layer and two dielectric layers. The first dielectric layer is disposed on a first side of the high voltage electrode layer and the second dielectric layer is disposed on the second, opposite side of the high voltage electrode layer. The ozone generator cell also includes two low voltage electrode layers comprising tungsten, wherein one low voltage electrode layer is disposed over each of the two dielectric layers. The ozone generator cell also includes two discharge regions. The first discharge region is defined, in part, by the high voltage electrode layer, the dielectric layer disposed on the first side of the high voltage electrode layer, and the low voltage electrode layer disposed on the first side of the high voltage electrode layer. The second discharge region is defined, in part, by the high voltage electrode layer, the dielectric layer disposed on the second side of the high voltage electrode layer, and the low voltage electrode layer disposed on the second side of the high voltage electrode layer. The ozone generator cell also includes two thermally conductive plates, the first thermally conductive plate in contact with the low voltage electrode layer on the first side of the high voltage electrode layer, and the second thermally conductive plate in contact with the low voltage electrode layer on the second side of the high voltage electrode layer, wherein the two thermally conductive plates maintain contact between the layers located therebetween in the absence of a bonding agent.

**[0014]** In some embodiments, maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer. In some embodiments, the ozone generator cell includes spacer shims protruding from a surface of each low voltage electrode layer towards a surface of a dielectric layer. In some embodiments, the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer, and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage electrode layers and the second side of the high voltage electrode layer. In some embodiments, the spacer shims are integral portions of the low voltage electrode layers or separate components sandwiched between the dielectric layers and the low voltage electrode layers.

[0015] Herein disclosed is~~The invention, in another aspect, features~~ a high concentration ozone generator cell that includes a high voltage electrode layer fabricated using non-aluminum containing materials. The cell also includes two dielectric layers, the first dielectric layer disposed on a first side of the high voltage electrode layer and the second dielectric layer disposed on the second, opposite side of the high voltage electrode layer. The cell also includes two low voltage electrode layers, one low voltage electrode layer disposed over each of the two dielectric layers fabricated using non-aluminum containing materials. The cell also includes two discharge regions lacking aluminum containing materials, the first discharge region defined, in part, by the high voltage electrode layer, the dielectric layer disposed on the first side of the high voltage electrode layer, and the low voltage electrode layer disposed on the first side of the high voltage electrode layer, the second discharge region defined, in part, by the high voltage electrode layer, the dielectric layer disposed on the second side of the high voltage electrode layer, and the low voltage electrode layer disposed on the second side of the high voltage electrode layer. The cell also includes two thermally conductive plates, the first thermally conductive plate in contact with the low voltage electrode layer on the first side of the high voltage electrode layer, and the second thermally conductive plate in contact with the low voltage electrode layer on the second side of the high voltage electrode layer, wherein the two thermally conductive plates maintain contact between the layers located therebetween in the absence of a bonding agent to reduce the shear stresses in the ozone generator cell.

[0016] Other aspects and advantages of the current invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating the principles of the invention by way of example only.

## Brief Description of the Drawings

[0017] The foregoing features of various embodiments of the invention will be more readily understood by reference to the following detailed descriptions in the accompanying drawings, in which:

[0018] FIG. 1 is a schematic illustration of an ozone generator, according to an illustrative embodiment of the invention.

[0019] FIG. 2A is a schematic illustration of an exploded view of an ozone generator cell, according to an illustrative embodiment of the invention.

## CLAIMS

1. An ozone generator, comprising:

an ozone generator cell comprising:

a high voltage electrode layer having a first side and a second side opposing the first side;

a first dielectric layer having a first side and a second side opposing the first side,and a second dielectric layer having a first side and a second side opposing the first side, the second side of the first dielectric layer disposed on the first side of the high voltage electrode layer and the first side of the second dielectric layer disposed on the second side of the high voltage electrode layer;

a first low voltage electrode layer having a first side and a second side opposing the first side, and a second low voltage electrode layer having a first side and a second side opposing the first side, the second side of the first low voltage electrode layer disposed over the first side of the first dielectric layer and the first side of the second low voltage electrode layer disposed over the second side of the second dielectric layer;

two discharge regions, a first discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the first dielectric layer disposed on the first side of the high voltage electrode layer, and the second side of the first low voltage electrode layer disposed on the first side of the first dielectric layer, a second discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the second dielectric layer disposed on the second side of the high voltage electrode layer, and the first side of the second low voltage electrode layer disposed on the second side of the second dielectric layer; and

a first thermally conductive plate having a first side and a second side opposing the first side, and a second thermally conductive plate having a first side and a second side opposing the first side, the second side of the first thermally conductive plate disposed over the first side of the first low voltage electrode layer and the first side of the second thermally conductive plate disposed over the second side of the second low voltage electrode layer, wherein the two thermally conductive plates maintain contact between the first low voltage electrode layer, the first dielectric layer, the high voltage

electrode layer, the second dielectric layer, and the second low voltage electrode layer located therebetween in the absence of a bonding agent,

wherein the two dielectric layers, the two low voltage electrode layers, and the high voltage electrode layer are all fabricated using non-aluminum containing materials.

2. The ozone generator of claim 1, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer.

3. The ozone generator of claim 2, wherein the reduced thickness produces an increased capacitance between the low voltage electrode layers and the high voltage electrode layer.

4. The ozone generator of claim 1, comprising spacer shims protruding from a surface of each low voltage electrode layer towards a surface of each of the two dielectric layers.

5. The ozone generator of claim 4, wherein the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer, and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage electrode layers and the second side of the high voltage electrode layer.

6. The ozone generator claim 4, wherein the spacer shims are integral portions of the low voltage electrode layers or separate components sandwiched between the dielectric layers and the low voltage electrode layers.

7. The ozone generator of claim 1, further comprising:

a base plate over which the ozone generator cell is positioned; and

a spring-loaded clamp plate coupled to the base plate such that the ozone generator cell is disposed between the base plate and the spring-loaded clamp plate, such that the coupled base plate and spring-loaded clamp plate apply pressure to the ozone generator cell to hold the layers of the ozone generator cell together.

8. A method for fabricating an ozone generator cell, the method comprising:

locating a second side of a first dielectric layer on a first side of a high voltage electrode layer;

locating a first side of a second dielectric layer on a second, opposite side of the high voltage electrode layer;

locating a second side of a first low voltage electrode layer over a first side of the first dielectric layer to define a first discharge region by combination of the high voltage electrode layer, the first dielectric layer and the first low voltage electrode layer;

locating a first side of a second low voltage electrode layer over a second side of the second dielectric layer to define a second discharge region by combination of the high voltage electrode layer, the second dielectric layer and the second low voltage electrode layer;

locating a first thermally conductive plate over a first side of the first low voltage electrode layer;

locating a second thermally conductive plate over the second side of the second low voltage electrode layer; and

applying pressure to the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located between the first and second thermally conductive plates to maintain contact between the layers located therebetween in the absence of a bonding agent.

9. The method of claim 8, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces an increased electrical capacitance between the low voltage electrode layers and

the high voltage electrode layer.

10. The method of claim 8, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent reduces thermal variation effects in the ozone generator cell.

11. The method of claim 10, wherein the ozone generator cell may be operated over a wider range of temperatures because of the absence of a bonding agent.

12. The method of claim 8, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer.

13. The method of claim 8, comprising fabricating all of the dielectric layers, the low voltage electrode layers, and the high voltage electrode layer using non-aluminum-containing materials.

14. The method of claim 8, comprising using an assembly jig to locate the first dielectric layer, the high voltage electrode layer, the second dielectric layer, the first low voltage electrode layer, the second low voltage electrode layer, the first thermally conductive plate, and the second thermally conductive plate relative to each other.

15. The method of claim 8, wherein spacer shims protrude from a surface of each low voltage electrode layer towards a surface of a dielectric layer.

16. The method of claim 15, wherein the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer, and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage

electrode layers and the second side of the high voltage electrode layer.

17. The method of claim 8, further comprising:

locating a base plate over the second thermally conductive plate;

locating a spring-loaded clamp plate over the first thermally conductive plate; and

coupling the spring-loaded clamp plate to the base plate, the coupled spring-loaded clamp plate and base plate applying the pressure to the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located between the first and second thermally conductive plates to maintain contact between the layers located therebetween.

18. An ozone generator, comprising:

an ozone generator cell comprising:

a high voltage electrode layer having a first side and a second side opposing the first side;

a first dielectric layer having a first side and a second side opposing the first side, and a second dielectric layer having a first side and a second side opposing the first side, the second side of the first dielectric layer disposed on the first side of the high voltage electrode layer and the first side of the second dielectric layer disposed on the second side of the high voltage electrode layer;

a first low voltage electrode layer comprising tungsten and having a first side and a second side opposing the first side, and a second low voltage electrode layer comprising tungsten and having a first side and a second side opposing the first side, the second side of the first low voltage electrode layer disposed over the first side of the first dielectric layer and the first side of the second low voltage electrode layer disposed over the second side of the second dielectric layer;

two discharge regions, a first discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the first dielectric layer disposed on the first side of the high voltage electrode layer, and the second side of the first low voltage electrode layer disposed on the first side of the first dielectric layer, a second discharge region, of the two discharge regions, defined, in part, by the high voltage

electrode layer, the second dielectric layer disposed on the second side of the high voltage electrode layer, and the first side of the second low voltage electrode layer disposed on the second side of the second dielectric layer; and

a first thermally conductive plate having a first side and a second side opposing the first side, and a second thermally conductive plate having a first side and a second side opposing the first side, the second side of the first thermally conductive plate disposed over the first side of the first low voltage electrode layer and the first side of the second thermally conductive plate disposed over the second side of the second low voltage electrode layer, wherein the two thermally conductive plates maintain contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer layers located therebetween in the absence of a bonding agent.

19. The ozone generator of claim 18, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer.

20. The ozone generator of claim 18, comprising spacer shims protruding from a surface of each low voltage electrode layer towards a surface of a dielectric layer.

21. The ozone generator of claim 20, wherein the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer, and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage electrode layers and the second side of the high voltage electrode layer.

22. The ozone generator claim 20, wherein the spacer shims are integral portions of the low voltage electrode layers or separate components sandwiched between the dielectric layers and the low voltage electrode layers.

23. The ozone generator of claim 18, further comprising:

a base plate over which the ozone generator cell is positioned; and

a spring-loaded clamp plate coupled to the base plate such that the ozone generator cell is disposed between the base plate and the spring-loaded clamp plate, such that the coupled base plate and spring-loaded clamp plate apply pressure to the ozone generator cell to maintain the contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer layers located therebetween in the absence of a bonding agent.

24. A high concentration ozone generator, comprising:

an ozone generator cell comprising:

a high voltage electrode layer fabricated using non-aluminum containing materials having a first side and a second side opposing the first side;

a first dielectric layer having a first side and a second side opposing the first side, and a second dielectric layer having a first side and a second side opposing the first side, the second side of the first dielectric layer disposed on the first side of the high voltage electrode layer and the first side of the second dielectric layer disposed on the second side of the high voltage electrode layer;

a first low voltage electrode layer having a first side and a second side opposing the first side, and a second low voltage electrode layer having a first side and a second side opposing the first side, the second side of the first low voltage electrode layer disposed over the first side of the first dielectric layer and the first side of the second low voltage electrode layer disposed over the second side of the second dielectric layer;

two discharge regions lacking aluminum-containing materials, a first discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the first dielectric layer disposed on the first side of the high voltage electrode layer, and the second side of the first low voltage electrode layer disposed on the first side of the first dielectric layer, a second discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the second dielectric layer disposed on the second side of the high voltage electrode layer, and the first side of the second low voltage electrode layer disposed on the second side of the second dielectric layer; and

a first thermally conductive plate having a first side and a second side opposing the first side, and a second thermally conductive plate having a first side and a second side opposing the first side, the second side of the first thermally conductive plate disposed over the first side of the first low voltage electrode layer and the first side of the second thermally conductive plate disposed over the second side of the second low voltage electrode layer, wherein the two thermally conductive plates maintain contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located therebetween in the absence of a bonding agent to reduce the shear stresses in the ozone generator cell.

25. The high concentration ozone generator cell of claim 24, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer.

26. The high concentration ozone generator cell of claim 24, comprising spacer shims protruding from a surface of each low voltage electrode layer towards a surface of a dielectric layer.

27. The high concentration ozone generator cell of claim 26, wherein the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer, and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage electrode layers and the second side of the high voltage electrode layer.

28. The high concentration ozone generator cell of claim 26, wherein the spacer shims are integral portions of the low voltage electrode layers or separate components sandwiched between the dielectric layers and the low voltage electrode layers.

29. The high concentration ozone generator cell of claim 24, further comprising:

a base plate over which the ozone generator cell is positioned; and

a spring-loaded clamp plate coupled to the base plate such that the ozone generator cell is disposed between the base plate and the spring-loaded clamp plate, such that the coupled base plate and spring-loaded clamp plate apply pressure to the ozone generator cell to maintain the contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer layers located therebetween in the absence of a bonding agent to reduce the shear stresses in the ozone generator cell.

# CLAIMS

1. An ozone generator comprising:

an ozone generator cell comprising:

a high voltage electrode layer having a first side and a second side opposing the first side,

a first dielectric layer having a first side and a second side opposing the first side, and a second dielectric layer having a first side and a second side opposing the first side, the second side of the first dielectric layer disposed on the first side of the high voltage electrode layer and the first side of the second dielectric layer disposed on the second side of the high voltage electrode layer,

a first low voltage electrode layer having a first side and a second side opposing the first side, and a second low voltage electrode layer having a first side and a second side opposing the first side, the second side of the first low voltage electrode layer disposed over the first side of the first dielectric layer and the first side of the second low voltage electrode layer disposed over the second side of the second dielectric layer,

two discharge regions, a first discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the first dielectric layer disposed on the first side of the high voltage electrode layer, and the second side of the first low voltage electrode layer disposed on the first side of the first dielectric layer, a second discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the second dielectric layer disposed on the second side of the high voltage electrode layer, and the first side of the second low voltage electrode layer disposed on the second side of the second dielectric layer, and

a first thermally conductive plate having a first side and a second side opposing the first side, and a second thermally conductive plate having a first side and a second side opposing the first side, the second side of the first thermally conductive plate disposed over the first side of the first low voltage electrode layer and the first side of the second thermally conductive plate disposed over the second side of the second low voltage electrode layer, wherein the two thermally conductive plates maintain contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located therebetween in the absence of a bonding agent;

a base plate over which the ozone generator cell is positioned; and

a spring-loaded clamp plate coupled to the base plate such that the ozone generator cell is disposed between the base plate and the spring-loaded clamp plate, such that

the coupled base plate and spring-loaded clamp plate apply pressure to the ozone generator cell to hold the layers of the ozone generator cell together,

wherein the two dielectric layers, the two low voltage electrode layers, and the high voltage electrode layer are all fabricated using non-aluminum containing materials.

2. The ozone generator cell of claim 1, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer.

3. The ozone generator cell of claim 2, wherein the reduced thickness produces an increased capacitance between the low voltage electrode layers and the high voltage electrode layer.

4. The ozone generator cell of claim 1, comprising spacer shims protruding from a surface of each low voltage electrode layer towards a surface of each of the two dielectric layers.

5. The ozone generator cell of claim 4, wherein the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer, and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage electrode layers and the second side of the high voltage electrode layer.

6. The ozone generator cell claim 4, wherein the spacer shims are integral portions of the low voltage electrode layers or separate components sandwiched between the dielectric layers and the low voltage electrode layers.

7. A method for fabricating an ozone generator cell, the method comprising:
locating a second side of a first dielectric layer on a first side of a high voltage electrode layer;

locating a first side of a second dielectric layer on a second, opposite side of the high voltage electrode layer;

locating a second side of a first low voltage electrode layer over a first side of the first dielectric layer to define a first discharge region by combination of the high voltage electrode layer, the first dielectric layer and the first low voltage electrode layer;

locating a first side of a second low voltage electrode layer over a second side of the second dielectric layer to define a second discharge region by combination of the high voltage electrode layer, the second dielectric layer and the second low voltage electrode layer;

locating a first thermally conductive plate over a first side of the first low voltage electrode layer;

locating a second thermally conductive plate over the second side of the second low voltage electrode layer;

locating a base plate over the second thermally conductive plate;

locating a spring-loaded clamp plate over the first thermally conductive plate; and

coupling the spring-loaded clamp plate to the base plate, the coupled spring-loaded clamp plate and base plate applying pressure to the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located between the first and second thermally conductive plates to maintain contact between the layers located therebetween in the absence of a bonding agent.

8. The method of claim 7, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces an increased electrical capacitance between the low voltage electrode layers and the high voltage electrode layer.

9. The method of claim 7, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent reduces thermal variation effects in the ozone generator cell.

10. The method of claim 9, wherein the ozone generator cell may be operated over a wider range of temperatures because of the absence of a bonding agent.

11. The method of claim 7, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer.

12. The method of claim 7, comprising fabricating all of the dielectric layers, the low voltage electrode layers, and the high voltage electrode layer using non-aluminum containing materials.

13. The method of claim 7, comprising using an assembly jig to locate the first dielectric layer, the high voltage electrode layer, the second dielectric layer, the first low voltage electrode layer, the second low voltage electrode layer, the first thermally conductive plate, and the second thermally conductive plate relative to each other.

14. The method of claim 7, wherein spacer shims protrude from a surface of each low voltage electrode layer towards a surface of a dielectric layer.

15. The method of claim 14, wherein the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer, and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage electrode layers and the second side of the high voltage electrode layer.

16. An ozone generator comprising:

an ozone generator cell comprising:

a high voltage electrode layer having a first side and a second side opposing the first side,

a first dielectric layer having a first side and a second side opposing the first side, and a second dielectric layer having a first side and a second side opposing the first side, the second side of the first dielectric layer disposed on the first side of the high voltage electrode layer and the first side of the second dielectric layer disposed on the second side of the high voltage electrode layer,

a first low voltage electrode layer comprising tungsten and having a first side and a second side opposing the first side, and a second low voltage electrode layer comprising tungsten and having a first side and a second side opposing the first side, the second side of the first low voltage electrode layer disposed over the first side of the first dielectric layer and the first side of the second low voltage electrode layer disposed over the second side of the second dielectric layer,

two discharge regions, a first discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the first dielectric layer disposed on the first side of the high voltage electrode layer, and the second side of the first low voltage electrode layer disposed on the first side of the first dielectric layer, a second discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the second dielectric layer disposed on the second side of the high voltage electrode layer, and the first side of the second low voltage electrode layer disposed on the second side of the second dielectric layer, and

a first thermally conductive plate having a first side and a second side opposing the first side, and a second thermally conductive plate having a first side and a second side opposing the first side, the second side of the first thermally conductive plate disposed over the first side of the first low voltage electrode layer and the first side of the second thermally conductive plate disposed over the second side of the second low voltage electrode layer, wherein the two thermally conductive plates maintain contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located therebetween in the absence of a bonding agent;

a base plate over which the ozone generator cell is positioned; and

a spring-loaded clamp late coupled to the base plate such that the generator cell is disposed between the base plate and the spring-loaded clamp plate, such that the coupled base plate and spring-loaded clamp plate apply pressure to the ozone generator cell to maintain the contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer and the second low voltage electrode layer located therebetween in the absence of a bonding agent.

17. The ozone generator cell of claim 16, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer.

18. The ozone generator cell of claim 16, comprising spacer shims protruding from a surface of each low voltage electrode layer towards a surface of a dielectric layer.

19. The ozone generator cell of claim 18, wherein the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer, and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage electrode layers and the second side of the high voltage electrode layer.

20. The ozone generator cell claim 18, wherein the spacer shims are integral portions of the low voltage electrode layers or separate components sandwiched between the dielectric layers and the low voltage electrode layers.

21. A high concentration ozone generator comprising:

an ozone generator cell comprising:

a high voltage electrode layer fabricated using non-aluminum containing materials having a first side and a second side opposing the first side,

a first dielectric layer having a first side and a second side opposing the first side, and a second dielectric layer having a first side and a second side opposing the first side, the second side of the first dielectric layer disposed on the first side of the high voltage electrode layer and the first side of the second dielectric layer disposed on the second side of the high voltage electrode layer,

a first low voltage electrode layer having a first side and a second side opposing the first side, and a second low voltage electrode layer having a first side and a second side opposing the first side, the second side of the first low voltage electrode layer disposed over the first side of the first dielectric layer and the first side of the second

low voltage electrode layer disposed over the second side of the second dielectric layer,

two discharge regions lacking aluminum containing materials, a first discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the first dielectric layer disposed on the first side of the high voltage electrode layer, and the second side of the first low voltage electrode layer disposed on the first side of the first dielectric layer, a second discharge region, of the two discharge regions, defined, in part, by the high voltage electrode layer, the second dielectric layer disposed on the second side of the high voltage electrode layer, and the first side of the second low voltage electrode layer disposed on the second side of the second dielectric layer, and

a first thermally conductive plate having a first side and a second side opposing the first side, and a second thermally conductive plate having a first side and a second side opposing the first side, the second side of the first thermally conductive plate disposed over the first side of the first low voltage electrode layer and the first side of the second thermally conductive plate disposed over the second side of the second low voltage electrode layer, wherein the two thermally conductive plates maintain contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located therebetween in the absence of a bonding agent to reduce the shear stresses in the ozone generator cell;

a base plate over which the ozone generator cell is positioned; and

a spring-loaded clamp plate coupled to the base plate such that the ozone generator cell is disposed between the base plate and the spring-loaded clamp plate, such that the coupled base plate and spring-loaded clamp plate apply pressure to the ozone generator cell to maintain the contact between the first low voltage electrode layer, the first dielectric layer, the high voltage electrode layer, the second dielectric layer, and the second low voltage electrode layer located therebetween in the absence of a bonding agent to reduce the shear stresses in the ozone generator cell.

22. The high concentration ozone generator cell of claim 21, wherein maintaining contact between the layers located between the first and second thermally conductive plates in the absence of a bonding agent produces a reduced thickness of a combination of the dielectric layers and the high voltage electrode layer.

23. The high concentration ozone generator cell of claim 21, comprising spacer shims protruding from a surface of each low voltage electrode layer towards a surface of a dielectric layer.

24. The high concentration ozone generator cell of claim 23, wherein the first dielectric layer is sandwiched between the spacer shims protruding from the surface of one of the low voltage electrode layers and the first side of the high voltage electrode layer,

and the second dielectric layer is sandwiched between the spacer shims protruding from the surface of the other of the low voltage electrode layers and the second side of the high voltage electrode layer.

25. The high concentration ozone generator cell of claim 23, wherein the spacer shims are integral portions of the low voltage electrode layers or separate components sandwiched between the dielectric layers and the low voltage electrode layers.