CLAIMS

1. An apparatus for generating plasma, comprising:

a vessel within which said plasma is generated; and

a coil configured to receive an RF driver signal to at least sustain said plasma, said coil having a coil length;

a first spine and a plurality of fingers extending from said first spine and circumferentially spaced apart from each other, each of said plurality of fingers are oriented along a longitudinal axis of said vessel and said plurality of fingers of said first spine and said first spine partially enclose a periphery of said vessel, said plurality of fingers of said first spine being electrically coupled to a first end of said coil; and

a second spine and a plurality of fingers extending from said second spine and circumferentially spaced apart from each other, each of said plurality of fingers are oriented along said longitudinal axis of said vessel and said plurality of fingers of said second spine and said second spine partially enclose said periphery of said vessel, said plurality of fingers of said second spine being electrically coupled to a second end of said coil,

wherein tips of said plurality of fingers of said first spine and second spine are oriented directionally in a direction to face each other and are axially separated along the longitudinal axis by a distance that is less than said coil length;

wherein the first spine, the second spine and the coil are located exterior to said vessel.

2. The apparatus of claim 1 wherein said coil is disposed at a greater radius from a said longitudinal axis of said vessel than said first and second spines and respective plurality of fingers.

3. The apparatus of claim 1 wherein one of said first end of said coil and said second end of said coil is coupled to ground.

4. The apparatus of claim 1 wherein the plurality of fingers of said first and second spines are disposed parallel to magnetic field lines generated when said coil is energized with said RF driver signal.

5. The apparatus of claim 1 wherein said vessel represents a plasma-generating vessel of an atmospheric inductively coupled plasma torch.

6. The apparatus of claim 1 wherein said coil is implemented by one of a tube-in-a-tube configuration and a side-by-side tubing configuration.

7. The apparatus of claim 1 wherein a first end of said coil is coupled to ground, said first end also represents an end for injecting and extracting cooling fluid.

8. The apparatus of claim 1 wherein the vessel has a cylindrical vertical wall portion and the plurality of fingers of the first and second spines are aligned exterior and adjacent the cylindrical vertical wall portion.

9. An apparatus for generating plasma, comprising:

a vessel within which said plasma is generated; and

a coil configured to receive an RF driver signal to sustain said plasma during operation, said coil having a coil length that has circumferential turns that circle around and outside the vessel;

a first spine having a plurality of fingers extending from said first spine, each of the plurality of fingers of said first spine being circumferentially spaced apart from each other, and each of said plurality of fingers of said first spine is oriented along a longitudinal axis of said vessel, wherein said plurality of fingers of said first spine and said first spine encircle a periphery of said vessel except for a first gap, said plurality of fingers of said first spine being electrically conductive and coupled to a first end of said coil; and

a second spine having a plurality of fingers extending from said second spine, each of the plurality of fingers of said second spine being circumferentially spaced apart from each other, and each of said plurality of fingers of said second spine is oriented along the longitudinal axis of said vessel, wherein said plurality of fingers of said second spine and said second spine encircle the periphery of said vessel except for a second gap, said plurality of fingers of said second spine being electrically conductive and coupled to a second end of said coil;

wherein the first spine and plurality of fingers and the second spine and plurality of fingers are spaced apart by a third gap, the third gap defined by a length between tip ends of the plurality of fingers of the first spine and the second spine that are oriented directionally to face each other along the longitudinal axis, the length being less than said coil length;

wherein the plurality of fingers of the first spine and the second spine are exterior to said vessel and disposed between the vessel and the coil.

10. The apparatus of claim 9 wherein one of said first end of said coil and said second end of said coil is coupled to ground.

11. The apparatus of claim 9 wherein said vessel represents a plasma-generating vessel of an atmospheric inductively coupled plasma torch.

12. The apparatus of claim 9 wherein said coil is implemented by one of a tube-in-a-tube configuration and a side-by-side tubing configuration.

13. The apparatus of claim 9 wherein a first end of said coil is coupled to ground, said first end also represents an end for injecting and extracting cooling fluid.

14. The apparatus of claim 9 wherein the vessel has a cylindrical vertical wall portion and the plurality of fingers of the first and second spines are aligned exterior and adjacent the cylindrical vertical wall portion.

15. The apparatus of claim 9 wherein the plurality of fingers of the first and second spines are disposed between the vessel and the coil.

16. An apparatus for generating a plasma, comprising:

a vessel for containing said plasma during operation;

an radio frequency (RF) source;

a coil coupled to said radio frequency (RF) source, said coil having a coil length that has circumferential turns that circle around and outside the vessel;

a first spine having a plurality of fingers extending from said first spine, each of the plurality of fingers of said first spine being circumferentially spaced apart from each other, and each of said plurality of fingers of said first spine is oriented along a longitudinal axis of said vessel, wherein said plurality of fingers of said first spine and said first spine encircle a periphery of said vessel except for a first gap, said plurality of fingers of said first spine being electrically conductive and coupled to a first end of said coil; and

a second spine having a plurality of fingers extending from said second spine, each of the plurality of fingers of said second spine being circumferentially spaced apart from each other, and each of said plurality of fingers of said second spine is oriented along the longitudinal axis

of said vessel, wherein said plurality of fingers of said second spine and said second spine encircle the periphery of said vessel except for a second gap, said plurality of fingers of said second spine being electrically conductive and coupled to a second end of said coil;

wherein the first spine and plurality of fingers and the second spine and plurality of fingers are spaced apart by a third gap, the third gap defined by a length between tips of the plurality of fingers of the first spine and the second spine, the first spine and the second spine being oriented at opposite sides of the tips of the plurality of fingers along the longitudinal axis;

wherein the tips of the plurality of fingers of the first spine and the second spine are oriented to directionally face each other, the length being less than said coil length;

wherein the plurality of fingers of the first spine and the second spine are disposed exterior said vessel and between the vessel and the coil.

17. The apparatus of claim 16, wherein the first and second gaps of each of the first and second spines are configured to reduce recirculating currents among said plurality of fingers.

18. The apparatus of claim 16 wherein said vessel represents a plasma-generating vessel of an atmospheric inductively coupled plasma torch, and wherein said coil is implemented by one of a tube-in-a-tube configuration and a side-by-side tubing configuration.

19. The apparatus of claim 16 wherein a first end of said coil is coupled to ground, said first end also represents an end for injecting and extracting cooling fluid.

20. The apparatus of claim 16 wherein the vessel has a cylindrical vertical wall portion and the plurality of fingers of the first and second spines are aligned exterior and adjacent the cylindrical vertical wall portion.

1. An apparatus for generating plasma, comprising:

a vessel within which said plasma is generated; and

a coil configured to receive an RF driver signal to at least sustain said plasma, said coil having a coil length;

a first set of partially enclosing, longitudinally oriented conductive (PELOC) fingers that are oriented along a longitudinal axis of said vessel and partially enclosing a periphery of said vessel, said first set of PELOC fingers being electrically coupled to a first end of said coil; and

a second set of partially enclosing, longitudinally oriented conductive (PELOC) fingers that are oriented along said longitudinal axis of said vessel and partially enclosing said periphery of said vessel, said second set of PELOC fingers being electrically coupled to a second end of said coil, wherein said first set of PELOC fingers and said second set of PELOC fingers are oriented such that fingertips of said first set of PELOC fingers point in a direction toward fingertips of said second set of PELOC fingers and separated by an inter-set distance that is less than said coil length.

2. The apparatus of claim 1 wherein said coil is disposed at a greater radius from a said longitudinal axis of said vessel than said first set of PELOC fingers.

3. The apparatus of claim 1 wherein one of said first end of said coil and said second end of said coil is coupled to ground.

4. The apparatus of claim 1 wherein fingers of said first set of PELOC fingers are disposed parallel to magnetic field lines generated when said coil is energized with said RF driver signal.

5. The apparatus of claim 4 wherein fingers of said second set of PELOC fingers are disposed parallel to said magnetic field lines.

6. The apparatus of claim 1 wherein said vessel represents a plasma-generating vessel of an atmospheric inductively coupled plasma torch.

7. The apparatus of claim 1 wherein said coil is implemented by one of a tube-in-a-tube configuration and a side-by-side tubing configuration.

8. The apparatus of claim 1 wherein a first end of said coil is coupled to ground, said first end also represents an end for injecting and extracting cooling fluid.

9. The apparatus of claim 1 wherein said RF driver signal has a frequency between about 10 MHz to about 100MHz.

10. An apparatus for generating plasma, comprising:

a cylinder within which said plasma is generated; and

a coil configured to receive an RF driver signal, said coil having a coil length and disposed at a first radial distance from a central longitudinal axis of said cylinder;

a first set of partially enclosing, longitudinally oriented conductive (PELOC) fingers that are oriented along said central longitudinal axis of said cylinder and partially enclosing a circumference of said cylinder, said first set of PELOC fingers being electrically coupled to a first end of said coil and disposed at a second radial distance from said central longitudinal axis of said cylinder; and

a second set of partially enclosing, longitudinally oriented conductive (PELOC) fingers that are oriented along said central longitudinal axis of said cylinder and partially enclosing said circumference of said cylinder, said second set of PELOC fingers being electrically coupled to a second end of said coil and disposed at a third radial distance from said central longitudinal axis of said cylinder, wherein said first set of PELOC fingers and said second set of PELOC fingers are oriented such that fingertips of said first set of PELOC fingers point in a direction toward fingertips of said second set of PELOC fingers and separated by an inter-set distance that is less than said coil length, and wherein said first radial distance is larger than either of said second radial distance and said third radial distance.

11. The apparatus of claim 10 wherein at least a portion of said first set of PELOC fingers and a portion of said second set of PELOC fingers are disposed between an outer surface of said cylinder and said coil.

12. The apparatus of claim 10 wherein one of said first end of said coil and said second end of said coil is coupled to ground.

13. The apparatus of claim 10 wherein fingers of said first set of PELOC fingers are disposed parallel to magnetic field lines generated when said coil is energized with said RF driver signal.

14. The apparatus of claim 13 wherein fingers of said second set of PELOC fingers are disposed parallel to said magnetic field lines.

15. The apparatus of claim 10 wherein said vessel represents a plasma-generating vessel of an atmospheric inductively coupled plasma torch.

16. The apparatus of claim 10 wherein said coil is implemented by one of a tube-in-a-tube configuration and a side-by-side tubing configuration.

17. The apparatus of claim 10 wherein a first end of said coil is coupled to ground, said first end also represents an end for injecting and extracting cooling fluid.

18. The apparatus of claim 10 wherein said RF driver signal has a frequency between about 10 MHz to about 100MHz.

19. An atmospheric inductively coupled plasma torch configured for processing plasma substrates with plasma, comprising:

means for confining said plasma, said means having at least an inlet for receiving a process gas and at least an open end for ejecting said plasma;

a coil wound around said cylinder, said coil configured for receiving an RF driver signal, said coil having a coil length; and

means electrically coupled to said coil and disposed at least partially around a periphery of said cylinder for effectively reducing a distance by which a coil voltage drops to less than said coil length, said coil voltage developed when said coil is energized by said driver RF signal.