

CLAIMS

1. An apparatus, comprising:
an inductively coupled plasma (ICP) antenna comprising a plurality of inductances electrically coupled in series; and
a capacitor coupled in parallel with an inductance of the plurality of inductances, wherein the ICP antenna is to be electromagnetically coupled to a plasma.
2. The apparatus of claim 1, wherein the inductance of the plurality of inductances is a first inductance, wherein the capacitor is a first capacitor of a plurality of capacitors, wherein the apparatus further comprises a second capacitor, and wherein the second capacitor is coupled in parallel with a second inductance of the plurality of inductances.
3. The apparatus of claim 2, wherein a third inductance of the plurality of inductances is between the first inductance and the second inductance.
4. The apparatus of claim 1, further comprising at least one series capacitor electrically coupled to an RF signal source and to the ICP antenna.
5. The apparatus of claim 4, wherein the at least one series capacitor is a fixed capacitor, a variable capacitor, or a combination thereof.
6. The apparatus of claim 2, wherein the first capacitor is further coupled in parallel with the first inductance and a fourth inductance, and wherein the fourth inductance and the first inductance are in electrical series with each other.
7. The apparatus of claim 6, wherein the second capacitor is coupled in parallel with the second inductance and a fifth inductance, and wherein the fifth inductance is of the plurality of inductances.
8. An apparatus, comprising:

an inductively coupled plasma (ICP) antenna comprising a coil, wherein the coil comprises:

a first terminal;

a second terminal;

a plurality of coil segments between the first terminal and the second terminal; and

a capacitor coupled in parallel with a coil segment of the plurality of coil segments.

9. The apparatus of claim 8, wherein the capacitor is above or below the coil segment.

10. The apparatus of claim 9, wherein the coil is a spiral coil, and wherein the spiral coil is substantially planar.

11. The apparatus of claim 10, wherein the capacitor is a first capacitor of a plurality of capacitors, wherein the coil segment is a first coil segment, and wherein individual ones of the plurality of capacitors are electrically coupled in parallel to one or more individual ones of the plurality of coil segments.

12. The apparatus of claim 11 wherein:

the first terminal of the first coil segment is at a first radius of the spiral coil, and the second terminal of the first coil segment is at a second radius of the spiral coil, and wherein the second radius is greater than the first radius;

the spiral coil comprises a second coil segment, wherein the second coil segment comprises a third terminal and a fourth terminal, wherein the third terminal is electrically coupled to the second terminal, and wherein the fourth terminal is at a third radius of the spiral coil;

the third radius is greater than the second radius; and

the second coil segment is substantially concentric with the first coil segment.

13. The apparatus of claim 12, wherein the coil comprises a third coil segment, wherein the third coil segment is between the first coil segment and the second coil segment, and wherein the third coil segment is electrically coupled in series with the first coil segment and with the second coil segment.

14. The apparatus of claim 13, wherein the first capacitor is coupled to the first coil segment, wherein the plurality of capacitors comprises a second capacitor and a third capacitor, wherein the second capacitor is coupled to the second coil segment, and wherein the third capacitor is coupled to the third coil segment.
15. The apparatus of claim 14, wherein the ICP antenna comprises a first tuned portion that comprises the first capacitor electrically coupled in parallel to any one of the first coil segment, the second coil segment or the third coil segment, wherein the first coil segment has a first inductance, wherein the second coil segment has a second inductance, wherein the third coil segment has a third inductance, wherein the first capacitor of the plurality of capacitors has a first capacitance, and wherein the first tuned portion is operable to resonate at a first RF frequency.
16. The apparatus of claim 15, wherein the ICP antenna comprises a second tuned portion that comprises the second capacitor of the plurality of capacitors electrically coupled in parallel to any one of the first coil segment, the second coil segment or the third coil segment, wherein the second capacitor of the plurality of capacitors has a second capacitance, and wherein the second tuned portion is operable to resonate at a second RF frequency.
17. The apparatus of claim 16, wherein the ICP antenna comprises a third tuned portion that comprises the third capacitor of the plurality of capacitors electrically coupled in parallel to any one of the first coil segment, the second coil segment or the third coil segment, wherein the third capacitor of the plurality of capacitors has a third capacitance, and wherein the third tuned portion is operable to resonate at a third RF frequency.
18. A semiconductor process tool, comprising:
a first chamber;
a second chamber, wherein the second chamber is adjacent to the first chamber, and
wherein the second chamber is separated from the first chamber by a wall that comprises a dielectric material;
an inductively coupled plasma (ICP) antenna within the first chamber, wherein the ICP antenna comprises a plurality of inductances, wherein individual ones of the plurality of inductances are electrically coupled in series to one another,

wherein at least one inductance of the plurality of inductances is electrically coupled in parallel to a capacitor; and
an RF signal source electrically coupled to the ICP antenna.

19. A method for tuning an inductively coupled plasma (ICP), comprising:
providing an ICP apparatus comprising:
an ICP antenna that comprises a plurality of inductances, wherein individual ones of the plurality of inductances are electrically coupled in series to one another, wherein at least one inductance of the plurality of inductances is electrically coupled in parallel to a capacitor;
a radio frequency (RF) signal source, wherein the ICP antenna is electrically coupled to the RF signal source, wherein the ICP antenna comprises at least one tuned portion, wherein the at least one tuned portion comprises a first inductance of the plurality of inductances coupled in parallel to the capacitor, wherein the at least one tuned portion comprises a tank circuit and has a resonant frequency, wherein the ICP antenna further comprises at least one untuned portion, and wherein the at least one untuned portion comprises a at least a second untuned inductance of the plurality of inductances electrically coupled to the at least one tuned portion of the ICP antenna; and
driving the ICP antenna by tuning the RF signal source to a frequency such that a ratio of a first current that circulates within the at least one tuned portion and a second current that flows in a least one untuned portion is greater than 1:1, wherein a plasma coupled to the ICP antenna is spatially regulated, and wherein a rate of a plasma-enhanced process is spatially regulated across a substrate.
20. The method of claim 19, wherein driving the ICP antenna by tuning the RF signal source comprises tuning the RF signal source to regulate a first electromagnetic field coupled to the at least one tuned portion of the ICP antenna relative to a second electromagnetic field coupled to the at least one untuned portion of the ICP antenna, wherein a first concentration of ions within a first portion of the plasma is regulated relative to a second concentration of ions within a second portion of the plasma, and wherein the second portion of the plasma is coupled to the at least one untuned portion.

21. The method of claim 20, further comprising tuning a series capacitance, wherein the series capacitance is series-coupled to the ICP antenna and to the RF signal source, wherein the series capacitance is tuned to regulate a capacitive reactance of the series capacitance, and wherein an input impedance of the ICP antenna is regulated by regulating the capacitive reactance of the series capacitance.

22. The method of claim 21, wherein an input voltage to the ICP antenna is decreased by tuning the series capacitance to regulate the input impedance of the ICP antenna.