

CLAIMS:

1. A non-thermal soft plasma cleaning system comprising:
a cleaning chamber containing a fluid at atmospheric pressure;
an electrode disposed in the cleaning chamber, wherein the electrode is connected to a power generator through a power matching unit; and
a dielectric member having an aperture is disposed adjacent to the electrode to guide or direct a plasma generated between the electrode and a workpiece, so that the plasma goes through the aperture to reach the workpiece in a sweeping direction;
wherein the workpiece is cleaned by the plasma without causing any plasma damage.
2. The non-thermal soft plasma cleaning system according to claim 1, wherein the fluid in the cleaning chamber is air or a gas; further comprising a feedstock gas to combine with the plasma to form a discharging fluid flow to guide the plasma to the workpiece and to expand a cleaning area, with the feedstock gas adding plasma species into the plasma.
3. The non-thermal soft plasma cleaning system according to claim 2, further comprising a second dielectric member with an aperture, with the second dielectric member being disposed substantially perpendicular to the dielectric member to constitute a plasma guiding and amplifying component.
4. The non-thermal soft plasma cleaning system according to claim 2, further comprising a second dielectric member with a second aperture, with the second dielectric member being disposed substantially parallel to the dielectric member such that the (first) aperture is not in line with the second aperture, so as to constitute a plasma guiding and amplifying component.
5. The non-thermal soft plasma cleaning system according to any one of claims 1-4, further comprising a floating electrode disposed in the cleaning chamber, wherein the floating electrode is connected to a tuning network of resistor, inductor and capacitor, with the tuning network connected to ground or a bias to provide further control over both an electric field component and ion energy in the plasma.

6. The non-thermal soft plasma cleaning system according to claim 5 comprising two or more floating electrodes.
7. The non-thermal soft plasma cleaning system according to claim 5 or 6, wherein the floating electrode is a plate, a plate with perforations or a grid mesh
8. The non-thermal soft plasma cleaning system according to any one of claims 2-7, further comprising a deflector to preionise, guide or direct the discharging fluid in the cleaning chamber to the workpiece.
9. The non-thermal soft plasma cleaning system according to any one of claims 1-8, wherein the workpiece is a test socket and a cavity of the test socket forms the cleaning chamber.
10. The non-thermal soft plasma cleaning system according to any one of claims 1-8, wherein the workpiece is a wire bonder wedge, a pin of a probe card for testing semiconductor devices, a pin of a test socket for testing semiconductor devices or other devices susceptible to plasma ion damage.
11. The non-thermal soft plasma cleaning system according to claim 2, wherein the feedstock gas is an inert gas, nitrogen, hydrogen, compressed air, liquid carbon dioxide or liquid nitrogen.
12. The non-thermal soft plasma cleaning system according to claim 1, wherein the fluid in the cleaning chamber is a liquid.
13. The non-thermal soft plasma cleaning system according to claim 12, wherein the liquid is water, solvent or a chemical solution.
14. The non-thermal soft plasma cleaning system according to claim 13, further comprising salt ions dissolved in the water.

15. The non-thermal soft plasma cleaning system according to claim 12, further comprising an inlet for injecting water or solvent with salt ions or a chemical solution into the cleaning chamber.
16. The non-thermal soft plasma cleaning system according to claim 15, further comprising an inlet for injecting a feedstock gas into the cleaning chamber.
17. The non-thermal soft plasma cleaning system according to any one of claims 12-16, further comprising a floating electrode disposed between the electrode and the workpiece, with the floating electrode being connected to a tuning network of resistor, inductor and capacitor to provide further control over both an electric field component and ion energy in the plasma or liquid; and wherein the floating electrode is made of a metal, ceramic, a semiconductor or an electric insulator.
18. The non-thermal soft plasma cleaning system according to any one of claims 12-17, further comprising a second dielectric member having an aperture, which is disposed to further guide or direct the plasma or ions in the liquid to reach the workpiece in the sweeping direction.
19. The non-thermal soft plasma cleaning system according to claim 17, wherein the floating electrode is a plate, a plate with perforations or a grid mesh.
20. A non-thermal soft plasma cleaning system comprising:
 - a cleaning chamber containing a fluid at atmospheric pressure;
 - an electrode disposed in the cleaning chamber, wherein the electrode is connected to a power generator through a power matching unit; and
 - a plasma guiding and amplifying component disposed near the electrode, wherein the plasma guiding and amplifying component comprises a first dielectric member with a first aperture and a second dielectric member with a second aperture, such that the first and second apertures are not inline, so that a path of a plasma generated between the electrode and a workpiece is substantially indirect.

21. The non-thermal soft plasma cleaning system according to claim 20, further comprising a feedstock gas, which combines with the plasma to form a discharging fluid flow,
22. The non-thermal soft plasma cleaning system according to claim 21, further comprising a deflector to guide or direct the discharging fluid in the cleaning chamber to the workpiece.
23. The non-thermal soft plasma cleaning system according to any one of claims 20-22, wherein the fluid in the cleaning chamber is air, gas or liquid.
24. The non-thermal soft plasma cleaning system according to claim 23, wherein when the fluid is a liquid, the fluid comprises a salt solution.