CLAIMS

1. An apparatus for ion manipulations, comprising:

at least one surface;

a first plurality of continuous electrodes coupled to the at least one surface and in electrical communication with a radiofrequency (RF) voltage source, in which an RF voltage applied to adjacent electrodes of the first plurality of electrodes by the RF voltage source is phase shifted on the adjacent electrodes of the first plurality of electrodes by approximately 180°; and

a second plurality of segmented electrodes coupled to the at least one surface and arranged in longitudinal sets between or adjacent to the first plurality of electrodes, the second plurality of segmented electrodes being further in electrical communication with an alternating current (AC) voltage source, in which an AC voltage waveform applied to adjacent electrodes within a longitudinal set of the second plurality of segmented electrodes by the AC voltage source is phase shifted on the adjacent electrodes of the second plurality of electrodes by 1°-359°.

2. An apparatus according to Claim 1, further comprising a plurality of guard electrodes positioned on outer ends of the first and second plurality of electrodes on the at least one surface, the plurality of guard electrodes being further in electrical communication with a DC voltage source, in which the plurality of guard electrodes generate electric fields that constrain ion motion towards the guard electrodes when receiving a constant DC voltage from the DC voltage source.

3. An apparatus according to Claim 1, in which the AC voltage waveform is a sine wave.

4. An apparatus according to Claim 3, in which the AC voltage waveform is the sum of more than one AC voltage waveform.

5. An apparatus according to Claim 1, in which the AC voltage waveform applied to adjacent electrodes within a longitudinal set of the second plurality of segmented electrodes is phase shifted on the adjacent electrodes of the second plurality of segmented electrodes in a repeating pattern.

6. An apparatus according to Claim 5, in which the AC voltage waveform applied to adjacent electrodes within a longitudinal set of the second plurality of segmented electrodes is phase shifted by approximately 45°, 90° or 120° on the adjacent electrodes of the second plurality of electrodes in a stepwise fashion.

7. An apparatus according to Claim 1, in which the at least one surface comprises a single and non-planar surface.

8. An apparatus according to Claim 7, in which the single, non-planar surface is one of the following shapes: curved, cylindrical, a spiral, a funnel, hemispherical, or elliptical.

9. An apparatus according to Claim 1, in which the at least one surface comprises two surfaces spaced apart from one another.

10. An apparatus according to Claim 9, in which the two surfaces are approximately parallel to one another.

11. An apparatus according to Claim 1, in which a frequency of the applied AC voltage waveform is selected from the range of 10 Hz - 200 kHz, and a frequency of the applied RF voltage is selected from the range of 100 kHz – 5 MHz.

12. An apparatus according to Claim 1, in which a frequency applied AC voltage waveform is selected from the range of 1 Hz to 1 kHz.

13. An apparatus according to Claim 1, in which a pressure range of the apparatus is from atmospheric pressure to 1 mtorr vacuum.

14. A method for performing ion manipulations, comprising:

providing at least one surface comprising:

a first plurality of continuous electrodes coupled to the at least one surface and in electrical communication with a radiofrequency (RF) voltage source; and

a second plurality of segmented electrodes coupled to the at least one surface and arranged in longitudinal sets between or adjacent to the first plurality of electrodes, the second plurality of segmented electrodes being further in electrical communication with an alternating current (AC) voltage source;

applying, by the RF voltage source, an RF voltage to adjacent electrodes of the first plurality of electrodes, in which the applied RF voltage is phase shifted on the adjacent electrodes of the first plurality of electrodes by approximately 180°; and

applying, by the AC voltage source, an AC voltage waveform within a longitudinal set of the second plurality of segmented electrodes, in which the applied AC voltage waveform is phase shifted on the adjacent electrodes of the second plurality of electrodes by 1°-359°.

15. A method according to Claim 14, further comprising positioning a plurality of guard electrodes on outer ends of the first and second plurality of electrodes on the at least one surface, the plurality of guard electrodes being further in electrical communication with a DC voltage source, in which the plurality of guard electrodes generate electric fields that constrain ion motion towards the guard electrodes when receiving a constant DC voltage from the DC voltage source.

16. A method according to Claim 14, in which the AC voltage waveform is a sine wave.

17. A method according to Claim 16, in which the AC voltage waveform is the sum of more than one AC voltage waveform.

18. A method according to Claim 14, in which the applied AC voltage waveform is phase shifted on the adjacent electrodes of the second plurality of segmented electrodes in a repeating pattern.

19. A method according to Claim 18, in which the applied AC voltage waveform is phase shifted by approximately 45°, 90°, or 120°, on the adjacent electrodes of the second plurality of segmented electrodes in a stepwise fashion.

20. A method according to Claim 14, in which the at least one surface comprises a single and non-planar surface.

21. A method according to Claim 20, in which the single, non-planar surface is one of the following shapes: curved, cylindrical, a spiral, a funnel, hemispherical, or elliptical.

22. A method according to Claim 14, in which the at least one surface comprises two surfaces spaced apart from one another.

23. A method according to Claim 22, in which the two surfaces are approximately parallel to one another.

24. A method according to Claim 14, in which a frequency of the applied AC voltage waveform is selected from the range of 10 Hz - 200 kHz, and a frequency of the RF voltage is selected from the range of 100 kHz – 5 MHz.