CLAIMS

1. A device comprising:

a first surface;

a second surface adjacent to the first surface, the first and the second surfaces defining a first ion channel therebetween, the first ion channel extending along a first direction, the second surface comprising:

a first plurality of electrodes comprising a first electrode and a second electrode spaced apart from the first electrode along a second direction lateral to the first direction, the first plurality of electrodes extending along the first direction, in which the first electrode is configured to receive a first voltage signal and generate at least a portion of a pseudopotential that inhibits ions in the first ion channel from approaching the second surface;

a second plurality of electrodes located between the first electrode and the second electrode and arranged along the first direction, in which the second plurality of electrodes are configured to receive a second voltage signal to generate a first traveling drive potential that travels along the first direction, the first traveling drive potential configured to guide ions along the first ion channel; and

a controller electrically coupled to the first and the second surface, the controller configured to generate the first voltage signal and the second voltage signal, the second voltage signal including a traveling drive potential component and a static bias DC voltage component.

2. A device according to Claim 1, in which the second electrode is configured to receive a third voltage signal and generate at least a second portion of the first pseudopotential.

3. A device according to Claim 2, in which the first voltage signal is a first radio frequency (RF) signal and the third voltage signal is a second RF voltage signal, and a phase difference between the first RF voltage signal and the second RF voltage signal has a value in the range of about zero degrees to about 180 degrees.

4. A device according to Claim 3, in which the controller includes a first RF control circuit configured to generate the first RF voltage signal, and a second RF control circuit configured to generate the second RF voltage signal.

5. A device according to Claim 1, in which the second voltage signal is a current waveform and the controller includes a plurality of traveling wave control circuits configured to generate a plurality of traveling wave voltage signals, in which amplitudes and phases of the plurality of traveling wave voltage signals are predetermined, and in which the current waveform includes the plurality of traveling wave voltage signals.

6. A device according to Claim 5, in which the current waveform is a pulsed current waveform comprising one or more of a sawtooth current waveform, a rectangular current waveform and a sinusoidal current waveform, and in which one or more of the sawtooth current waveform, the rectangular current waveform and the sinusoidal current waveform are biased by the static bias DC voltage component.

7. A device according to Claim 5, in which the plurality of traveling wave control circuits includes one or more of a plurality of pulsed current control circuits and a plurality of direct current control circuits.

8. A device according to Claim 1, in which the controller includes a first RF control circuit configured to generate the first voltage signal and a first direct current (DC) control circuit configured to generate a first DC voltage signal, in which the first voltage signal is the first RF voltage signal and the second electrode is configured to receive the first DC voltage signal.

9. A device according to Claim 8, in which the first plurality of electrodes comprises a third electrode adjacent to the second electrode and extending along the first direction, the third electrode configured to receive the first voltage signal and generate a second portion of the pseudopotential.

10. A device according to Claim 9, in which the first and the second surfaces define a second ion channel therebetween, the second ion channel extending along the first direction, the second surface comprising:

a third plurality of electrodes located between the second electrode and the third electrode, in which the third plurality of electrodes are configured to receive a fourth voltage signal and generate a second traveling drive potential that travels parallel to the first direction, the second traveling drive potential configured to guide ions along the second ion channel,

in which the first ion channel is located between the first and the second electrode along the second direction and the second ion channel is located between the second and the third electrode along the second direction.

11. A device according to Claim 1, in which the second electrode of the first plurality of electrodes is electrically coupled to a ground potential.

12. A device according to Claim 1, in which the controller includes a DC control circuit configured to generate the static bias DC voltage component.

13. A device according to Claim 12, in which the first surface is coupled to one or more of:

a first ion manipulation device characterized by a first ion manipulation device potential, the first surface configured to receive ions from the first ion manipulation device; and

a second ion manipulation device characterized by a second ion manipulation device potential, the first surface configured to transfer ions to the second ion manipulation device;

in which a bias ion potential energy of an ion associated with the bias DC voltage signal is less than a first ion potential energy of the ion associated with the first ion manipulation device potential, and/or the bias ion potential energy is greater than a second ion potential energy of the ion associated with the second ion manipulation device potential.

14. A device according to Claim 13, in which the first ion manipulation device is an ion source and the second ion manipulation device is an ion detector, in which the first surface is coupled to the ion source at a first end of the first surface, and coupled to the ion detector at a second end of the first surface.

15. A method comprising:

providing a first surface and a second surface adjacent to the first surface, the first and the second surfaces defining a first ion channel therebetween, the first ion channel extending along a first direction, the second surface comprising:

a first plurality of electrodes comprising a first electrode and a second electrode spaced apart from the first electrode along a second direction lateral to the first direction, the first plurality of electrodes extending along the first direction, and

a second plurality of electrodes located between the first electrode and the second electrode and arranged along the first direction;

providing ions along the first ion channel;

applying, by a controller, a first voltage signal to the first electrode, in which the first electrode is configured to generate at least a portion of a pseudopotential that inhibits ions in the first ion channel from approaching the second surface,

applying, by the controller, a second voltage signal to the second plurality of electrodes, the second voltage signal including a traveling drive potential component and a static bias DC voltage component; and, in which the second plurality of electrodes are configured to generate a biased first traveling drive potential that travels along the first direction, the first traveling drive potential configured to guide ions along the first ion channel.

16. A device according to Claim 15, in which the first voltage signal is a first radio frequency (RF) signal and in which the controller further applies a third voltage signal that is a second RF voltage signal to the second electrode, and a phase difference between the first RF voltage signal and the second RF voltage signal has a value in the range of about zero degrees to about 180 degrees.

17. A device according to Claim 15, further comprising, applying by the controller, a third voltage signal to the second electrode, in which the second electrode is configured to generate at least a second portion of the first pseudopotential.

18. A device according to Claim 17, in which the controller includes a first RF control circuit configured to generate the first RF voltage signal and a second RF control circuit configured to generate the second RF voltage signal.

CLAIMS

1. A device comprising:

a first surface;

a second surface adjacent to the first surface, the first and the second surfaces defining a first ion channel therebetween, the first ion channel extending along a first direction, the second surface comprising:

a first plurality of electrodes comprising a first electrode and a second electrode spaced apart from the first electrode along a second direction lateral to the first direction, the first plurality of electrodes extending along the first direction, in which the first electrode is configured to receive a first voltage signal and generate at least a portion of a pseudopotential that inhibits ions in the first ion channel from approaching the second surface;

a second plurality of electrodes located between the first electrode and the second electrode and arranged along the first direction, in which the second plurality of electrodes are configured to receive a second voltage signal to generate a first traveling drive potential that travels along the first direction, the first traveling drive potential configured to guide ions along the first ion channel; and

a controller electrically coupled to the first and the second surface, the controller configured to generate the first voltage signal and the second voltage signal, the second voltage signal including a pulsed current component and a static bias DC voltage component; and

in which the second surface is coupled to first and second ion manipulation devices, the first ion manipulation device characterized by a first ion manipulation device potential, the first ion channel configured to receive ions from the first ion manipulation device; and the second ion manipulation device characterized by a second ion manipulation device potential, the first ion channel configured to transfer ions to the second ion manipulation device; and

in which the static DC bias voltage component has a magnitude which maintains the traveling drive potential offset from ground thereby preventing a sign reversal and

creates a potential gradient from the first ion manipulation device to the first ion channel and from the first ion channel to the second ion manipulation device.

2. A device according to Claim 1, in which the second electrode is configured to receive a third voltage signal and generate at least a second portion of the first pseudopotential.

3. A device according to Claim 2, in which the first voltage signal is a first radio frequency (RF) signal and the third voltage signal is a second RF voltage signal, and a phase difference between the first RF voltage signal and the second RF voltage signal has a value in the range of zero degrees to 180 degrees.

4. A device according to Claim 3, in which the controller includes a first RF control circuit configured to generate the first RF voltage signal, and a second RF control circuit configured to generate the second RF voltage signal.

5. A device according to Claim 1, in which the second voltage signal is a current waveform and the controller includes a plurality of traveling wave control circuits configured to generate a plurality of traveling wave voltage signals, in which amplitudes and phases of the plurality of traveling wave voltage signals are predetermined, and in which the current waveform includes the plurality of traveling wave voltage signals.

6. A device according to Claim 5, in which the current waveform is a pulsed current waveform comprising one or more of a sawtooth current waveform, a rectangular current waveform and a sinusoidal current waveform, and in which one or more of the sawtooth current waveform, the rectangular current waveform and the sinusoidal current waveform are biased by the static bias DC voltage component.

7. A device according to Claim 5, in which the plurality of traveling wave control circuits includes one or more of a plurality of pulsed current control circuits and a plurality of direct current control circuits.

8. A device according to Claim 1, in which the controller includes a first RF control circuit configured to generate the first voltage signal and a first direct current (DC) control circuit configured to generate a first DC voltage signal, in which the first voltage signal is the first RF voltage signal and the second electrode is configured to receive the first DC voltage signal.

9. A device according to Claim 8, in which the first plurality of electrodes comprises a third electrode adjacent to the second electrode and extending along the first direction, the third electrode configured to receive the first voltage signal and generate a second portion of the pseudopotential.

10. A device according to Claim 9, in which the first and the second surfaces define a second ion channel therebetween, the second ion channel extending along the first direction, the second surface comprising:

a third plurality of electrodes located between the second electrode and the third electrode, in which the third plurality of electrodes are configured to receive a fourth voltage signal and generate a second traveling drive potential that travels parallel to the first direction, the second traveling drive potential configured to guide ions along the second ion channel,

in which the first ion channel is located between the first and the second electrode along the second direction and the second ion channel is located between the second and the third electrode along the second direction.

11. A device according to Claim 1, in which the second electrode of the first plurality of electrodes is electrically coupled to a ground potential.

12. A device according to Claim 1, in which the controller includes a DC control circuit configured to generate the static bias DC voltage component.

13. A device according to Claim 12, in which the first surface is coupled to one or more of:

a first ion manipulation device characterized by a first ion manipulation device potential, the first surface configured to receive ions from the first ion manipulation device; and

a second ion manipulation device characterized by a second ion manipulation device potential, the first surface configured to transfer ions to the second ion manipulation device;

in which a bias ion potential energy of an ion associated with the bias DC voltage signal is less than a first ion potential energy of the ion associated with the first ion manipulation device potential, and/or the bias ion potential energy is greater than a

second ion potential energy of the ion associated with the second ion manipulation device potential.

14. A device according to Claim 13, in which the first ion manipulation device is an ion source and the second ion manipulation device is an ion detector, in which the first surface is coupled to the ion source at a first end of the first surface, and coupled to the ion detector at a second end of the first surface.

15. A method comprising:

providing a first surface and a second surface adjacent to the first surface, the first and the second surfaces defining a first ion channel therebetween, the first ion channel extending along a first direction, the second surface comprising:

a first plurality of electrodes comprising a first electrode and a second electrode spaced apart from the first electrode along a second direction lateral to the first direction, the first plurality of electrodes extending along the first direction, and

a second plurality of electrodes located between the first electrode and the second electrode and arranged along the first direction;

providing ions along the first ion channel;

applying, by a controller, a first voltage signal to the first electrode, in which the first electrode is configured to generate at least a portion of a pseudopotential that inhibits ions in the first ion channel from approaching the second surface,

applying, by the controller, a second voltage signal to the second plurality of electrodes, the second voltage signal including a traveling drive potential component and a static bias DC voltage component; and, in which the second plurality of electrodes are configured to generate a biased first traveling drive potential that travels along the first direction, the first traveling drive potential configured to guide ions along the first ion channel.

16. A method according to Claim 15, in which the first voltage signal is a first radio frequency (RF) signal and in which the controller further applies a third voltage signal that is a second RF voltage signal to the second electrode, and a phase difference between the first RF voltage signal and the second RF voltage signal has a value in the range of zero degrees to 180 degrees.

17. A method according to Claim 15, further comprising, applying by the controller, a third voltage signal to the second electrode, in which the second electrode is configured to generate at least a second portion of the first pseudopotential.

18. A method according to Claim 17, in which the controller includes a first RF control circuit configured to generate the first RF voltage signal and a second RF control circuit configured to generate the second RF voltage signal.