claims

1、A micro-droplet generating system characterised in that it comprises, comprises a microfluidic chip and a droplet driving unit connected to the microfluidic chip, wherein the microfluidic chip comprises an upper electrode plate and a lower electrode plate, a fluid channel layer is formed between the upper electrode plate and the lower electrode plate, at least one of the upper electrode plate and the lower electrode plate forms a plurality of suction points, and the suction points are used for adsorbing liquid; The liquid droplet driving unit is used for driving the liquid injected into the fluid channel layer to flow in the fluid channel layer so as to form liquid micro-droplets at the position of the suction point.

2、The micro-droplet generation system of claim 1, characterised in that it comprises, the upper electrode plate comprises an upper plate, a conductive layer and a first hydrophobic layer which are sequentially arranged; The lower plate comprises a second hydrophobic layer, a dielectric layer, an electrode layer and a substrate which are sequentially arranged, the first hydrophobic layer and the second hydrophobic layer are oppositely arranged, the fluid channel layer is formed between the first hydrophobic layer and the second hydrophobic layer, and the electrode layer comprises a plurality of electrodes arranged in an array.

3、The micro-droplet generation system of claim 2, wherein said suction point is formed by said electrodes actuated by said electrode layer, adjacent actuated electrodes being spaced apart by said electrodes not actuated.

4、The micro-droplet generating system of claim 2, wherein the upper electrode plate forms a hydrophilic point array on one side of the first hydrophobic layer far away from the conductive layer, the hydrophilic points of the hydrophilic point array are the suction points, and adjacent hydrophilic points are arranged at intervals.

5、The micro-droplet generation system of claim 2, wherein said electrode of the said electrode layer is hexagonal and/or square in shape.

6、The micro-droplet generation system of claim 2, wherein the electrode layer comprises a plurality of square electrodes arranged in an array and a plurality of hexagonal electrodes arranged in an array.

7、The micro-droplet generation system of claim 6, wherein the electrode layer comprises a plurality of hexagonal electrodes arranged in an array and a plurality of square electrodes arranged in an array on both sides of the plurality of hexagonal electrodes arranged in an array; wherein the side length of the hexagonal electrode is 50 μm to 2 mm, and the side length of the square electrode is 50 μm to 2 mm.

8、The micro-droplet generation system of claim 6, wherein the electrode layer comprises a plurality of regular-side electrodes arranged in an array and a plurality of hexagonal electrodes arranged in an array on both sides of the plurality of regular-side electrodes arranged in an

array; wherein the side length of the hexagonal electrode is 50 μm to 2 mm, and the side length of the square electrode is 50 μm to 2 mm.

~~9、The micro-droplet generating system of claim 7 or 8, wherein the side length of the hexagonal electrode is 50 μm to 2 mm, and the side length of the square electrode is 50 μm to 2 mm~~

9~~10~~、The micro-droplet generating system of claim 6, wherein the electrode layer comprises a plurality of first square electrodes arranged in an array, a plurality of first hexagonal electrodes arranged in an array, a plurality of second hexagonal electrodes arranged in an array, and a plurality of second square electrodes arranged in an array which are sequentially connected; wherein the 1st square electrode or the side length of the square electrode is 50 μm - 2 mm, the side length of the second square electrode is 1/5-1/2 of the side length of the first square electrode, the side length of the first hexagonal electrode is 50μm - 2mm, and the side length of the second hexagonal electrode is 1/5-1/2 of the side length of the first hexagonal electrode.

10~~1~~、The micro-droplet generating system of claim 6, wherein the electrode layer comprises a plurality of first hexagonal electrodes arranged in an array, a plurality of second hexagonal electrodes arranged in an array, and a plurality of square electrodes arranged in an array, which are sequentially connected; wherein the 1st square electrode or the side length of the square electrode is 50 μm - 2 mm, the side length of the second square electrode is 1/5-1/2 of the side length of the first square electrode, the side length of the first hexagonal electrode is 50μm - 2mm, and the side length of the second hexagonal electrode is 1/5-1/2 of the side length of the first hexagonal electrode.

~~12、The micro-droplet generation system of claim 10 or 11, characterized in that the 1st square electrode or the side length of the square electrode is 50 μm - 2 mm, the side length of the second square electrode is 1/5-1/2 of the side length of the first square electrode, the side length of the first hexagonal electrode is 50μm - 2mm, and the side length of the second hexagonal electrode is 1/5-1/2 of the side length of the first hexagonal electrode.~~

11~~3~~、A micro-droplet generation system according to any one of claims 2 to 5, characterised in that it comprises, the liquid droplet driving unit is an electrode driving unit connected to the electrode layer and used for controlling opening and closing of the electrode of the electrode layer so as to control the flow of liquid injected into the fluid channel layer in the fluid channel layer and form liquid micro-droplets at the position of the suction point.

12~~4~~、A micro-droplet generation system according to any one of claims 2 to 5, characterised in that it comprises, a liquid injection hole is formed in the center of the microfluidic chip; the liquid injection hole is used for injecting liquid into the fluid channel layer, the microfluidic chip is also provided with a plurality of liquid drain holes. The liquid drain hole is used for discharging excess liquid from the microfluidic chip, the droplet driving unit is a rotary driving unit, and the rotary driving unit is used for driving the microfluidic chip to rotate so that liquid

injected into the fluid channel layer forms micro-droplets at the suction point in a spin-coating mode;

wherein the rotation driving unit drives the microfluidic chip to rotate at a rotation speed greater than 0 rpm and less than or equal to 1000 rpm;

wherein the electrode is hexagonal, the side length of the electrode is 50μm - 2mm, and the distance between the first hydrophobic layer and the second hydrophobic layer is 5μm - 600μm.

~~15、The micro-droplet generation system of claim 14, wherein the rotation driving unit drives the microfluidic chip to rotate at a rotation speed greater than 0 rpm and less than or equal to 1000 rpm.~~

~~16、The micro-droplet generation system of claim 14, wherein the electrode is hexagonal, the side length of the electrode is 50μm - 2mm, and the distance between the first hydrophobic layer and the second hydrophobic layer is 5μm - 600μm.~~

13~~7~~、A micro-droplet generation system according to any one of claims 2 to 5, characterised in that it comprises, the microfluidic chip is provided with a first sample injection hole and a first sample drain hole, the first sample injection hole and the first sample drain hole are arranged on a first diagonal line of the microfluidic chip. The droplet driving unit includes a first micropump and a third micropump. The first micropump is connected to the first sample injection hole and is used for injecting liquid into the fluid channel layer so that the fluid channel layer is filled with the liquid, and the third micropump is connected to the first sample drain hole and is used for extracting the liquid or gas flowing out of the first sample drain hole so as to form micro-droplets at the suction point;

wherein the microfluidic chip is also provided with a second sample injection hole and a second sample drain hole, the second sample injection hole and the second sample drain hole are arranged on a second diagonal line of the microfluidic chip. The droplet driving unit further includes a second micropump and a fourth micropump. The second micropump is connected to the second sample injection hole and used for injecting medium into the fluid channel layer, and the fourth micropump is connected to the second sample drain hole and used for extracting excess liquid or medium flowing out of the second sample drain hole so that the liquid micro-droplets is wrapped by medium formed at the position of the suction point;

wherein the thickness of the upper plate is 0.05 mm to 1.7 mm, the thickness of the substrate is 0.05 mm to 1.7 mm, the thickness of the conductive layer is 10 nm to 500 nm, the thickness of the dielectric layer is 50 nm to 1000 nm, the thickness of the electrode layer is 10 nm to 1000 nm, the thickness of the first hydrophobic layer is 10 nm to 200 nm, and the thickness of the second hydrophobic layer is 10 nm to 200 nm.

~~18、The micro-droplet generation system of claim 17, characterised in that it comprises, the microfluidic chip is also provided with a second sample injection hole and a second sample~~

~~drain hole, the second sample injection hole and the second sample drain hole are arranged on a second diagonal line of the microfluidic chip. The droplet driving unit further includes a second micropump and a fourth micropump. The second micropump is connected to the second sample injection hole and used for injecting medium into the fluid channel layer, and the fourth micropump is connected to the second sample drain hole and used for extracting excess liquid or medium flowing out of the second sample drain hole so that the liquid micro-droplets is wrapped by medium formed at the position of the suction point.~~

~~19、The micro-droplet generation system of claim 17, wherein the thickness of the upper plate is 0.05 mm to 1.7 mm, the thickness of the substrate is 0.05 mm to 1.7 mm, the thickness of the conductive layer is 10 nm to 500 nm, the thickness of the dielectric layer is 50 nm to 1000 nm, the thickness of the electrode layer is 10 nm to 1000 nm, the thickness of the first hydrophobic layer is 10 nm to 200 nm, and the thickness of the second hydrophobic layer is 10 nm to 200 nm.~~

14~~20~~、A micro-droplet generating system characterised in that it comprises, comprises a microfluidic chip consisting of an upper electrode plate and a lower electrode plate, a fluid channel layer is formed between the upper electrode plate and the lower electrode plate, at least one of said upper plate and said lower plate forming a plurality of suction points, the suction point is used for adsorbing liquid, an included angle is formed between the plane of the upper electrode plate and the plane of the lower electrode plate, the upper electrode plate is provided with a plurality of sample injection holes, the sample injection hole is positioned at the edge of the upper electrode plate, the sample injection hole is used for injecting liquid, said fluid channel layer comprising a first end and a second end disposed opposite each other, the height of the first end of the fluid channel layer being less than the height of the second end of the fluid channel layer. When liquid is injected into the first end of the fluid channel layer through the sample injection hole, the liquid moves from the first end to the second end under the action of surface tension and forms micro-droplets at the suction point.

~~21、The micro-droplet generating system of claim 20, wherein an included angle between the upper plate and the lower plate is greater than 0 degrees and less than 3 degrees.~~

~~22、The micro-droplet generation system of claim 20, wherein at said first end, the distance between said upper plate and said lower plate is 0 μm to 200 μm~~

~~23、A micro-droplet generation system according to claim 20, characterised in that it comprises, the upper electrode plate comprises an upper plate, a conductive layer and a first hydrophobic layer which are sequentially arranged. The lower plate comprises a second hydrophobic layer, a dielectric layer, an electrode layer and a substrate which are sequentially arranged, the first hydrophobic layer and the second hydrophobic layer are oppositely arranged, the fluid channel layer is formed between the first hydrophobic layer and the second hydrophobic layer, and the electrode layer comprises a plurality of electrodes arranged in an array.~~

24、The micro-droplet generation system of claim 23, wherein said suction point is formed by said electrodes actuated by said electrode layer, adjacent actuated electrodes being spaced apart by said electrodes not actuated.

25、The micro-droplet generating system of claim 23, wherein the upper plate has a hydrophilic point array formed on one side of the first hydrophobic layer away from the conductive layer, the hydrophilic points of the hydrophilic point array are the suction points, and adjacent hydrophilic points are arranged at intervals.

26、The micro-droplet generation system of claim 23, wherein said electrode of said electrode layer is hexagonal and/or square in shape.

27、A micro-droplet generating method is characterized by comprising the following steps of:

S1, providing a microfluidic chip, said microfluidic chip comprising an upper plate and a lower plate, said upper plate and said lower plate forming a fluid channel layer therebetween;

S2, forming a plurality of suction points on at least one of said upper plate and said lower plate, said suction points for adsorbing liquid;

S3, injecting liquid into the fluid channel layer;

S4, driving the liquid to flow in the fluid channel layer to form micro-droplets at multiple suction points of the microfluidic chip.

28、The micro-droplet generation method of claim 27, characterized in that the upper plate comprises an upper plate, a conductive layer and a first hydrophobic layer which are sequentially stacked; The lower plate comprises a second hydrophobic layer, a dielectric layer, an electrode layer and a substrate which are sequentially stacked; The electrode layer comprises a plurality of electrodes arranged in an array, and the fluid channel layer is formed between the first hydrophobic layer and the second hydrophobic layer;

Said step S2 includes the following steps: opening several electrodes of the described electrode layer, the actuated electrodes can be formed into the described suction point, and between adjacent actuated electrodes the unactuated electrodes can be used for spacing arrangement.

29、The micro-droplet generation method of claim 27, characterized in that the upper plate comprises an upper plate, a conductive layer and a first hydrophobic layer which are sequentially stacked; The lower plate comprises a second hydrophobic layer, a dielectric layer, an electrode layer and a substrate which are sequentially stacked; The electrode layer comprises a plurality of electrodes arranged in an array, and the fluid channel layer is formed between the first hydrophobic layer and the second hydrophobic layer;

Said step S2 includes the following steps: utilizing laser or plasma to treat the hydrophobic coating layer at the required position of the first hydrophobic layer so as to form hydrophilic

points on the first hydrophobic layer, the hydrophilic points are suction points, and the adjacent hydrophilic points are alternatively placed.

30、The micro-droplet generation method of claim 28, wherein step S4 comprises the steps of:

S110, opening the electrodes of the first row to the P-th row so that the liquid forms large-droplets at positions of the fluid channel layer corresponding to the electrodes of the first row to the P-th row, wherein P is a positive integer;

S120, keeping the electrodes of the suction points of the first row open, closing the other electrodes of the first row, simultaneously opening the electrodes of the (P+1)th row, driving the large-droplets to move forward one row in the fluid channel layer, and forming micro-droplets at the suction points of the first row, at least one electrode being spaced between adjacent suction points;

S130, opening the electrodes holding the suction points of the second row, closing the other electrodes of the second row, simultaneously, opening the electrodes of the (P+2)th row, driving the large liquid droplets to move forward in the fluid channel layer by another row, and forming liquid micro-droplets at the suction points of the second row, at least one electrode being spaced between adjacent suction points, the suction points of the first row and the suction points of the second row being in different columns;

S140, opening the electrodes for holding the suction points of the n-th row, closing the other electrodes of the n-th row, simultaneously, opening the electrodes of the (P+n)th row, driving the large liquid droplets to move forward in the fluid channel layer by another row, and forming liquid micro-droplets at the suction points of the n-th row, wherein at least one electrode is spaced between adjacent suction points, the suction points of the n-th row and the suction points of the (n-1)th row are in different columns, wherein n is a positive integer greater than 3;

S150, repeating S140 to form multiple micro-droplets on the microfluidic chip until the large-droplets are depleted.

31、The micro-droplet generation method of claim 30, wherein step S4 comprises the steps of:

S210, opening the electrodes of the first row to the P-th row, the liquid in the fluid channel layer forming large droplets on the electrodes of the first row to the P-th row of the electrode layer, wherein P is a positive integer;

S220, closing the electrodes of the first row while opening the electrodes of the (P+1)th row, driving the large-droplets to move forward by one row in the fluid channel layer to form micro-droplets at the hydrophilic point of the first row;

S230, closing the electrodes of the second row while opening the electrodes of the (P+2)th row to drive the large-droplets to move forward one row in the electrode layer to form micro-droplets at the hydrophilic point of the second row;

S240, closing the electrodes of the n-th row while opening the electrodes of the (P+n)th row, driving the large droplets to move forward another row on the electrode layer, and forming micro-droplets at the hydrophilic point of the n-th row, wherein n is a positive integer greater than 3;

S250, repeating S240 to form multiple droplets on the microfluidic chip until the large droplets are depleted.

32、The micro-droplet generation method of claim 28, wherein step S4 comprises the step of rotating the microfluidic chip, the liquid in the fluid channel layer forming micro-droplets at locations corresponding to the plurality of actuated electrodes

33、The micro-droplet generation method of claim 30, wherein step S4 comprises the step of rotating the microfluidic chip, the liquid in the fluid channel layer forming micro-droplets at positions corresponding to the plurality of hydrophilic points.

34、The micro-droplet generation method of claim 32 or 33, wherein in step S4, the microfluidic chip is rotated at a rotational speed of greater than 0 rpm and less than or equal to 1000 rpm.

35、The micro-droplet generation method of claim 32 or 33, wherein in step S3, the liquid is injected from a liquid injection hole in the center of the microfluidic chip.

36、The method of claim 32 or 33, further comprising the step of stopping the rotation of the microfluidic chip when excess liquid flows out of the fluid channel layer.

37、The micro-droplet generation method of claim 28 or 30, characterised in that it comprises, an included angle is formed between the plane of the upper electrode plate and the plane of the lower electrode plate, said upper plate is provided with a plurality of sample injection holes at an edge of said upper plate, said sample injection holes for injecting a sample, said fluid channel layer including opposing first and second ends, said first end of said fluid channel layer having a height less than said second end of said fluid channel layer;

In step S3, the liquid is injected into the first end of the fluid channel layer through the sample injection hole, when the liquid is injected into the fluid channel layer, the liquid moves from the first end to the second end under the action of surface tension, and the liquid forms micro-droplets at a position corresponding to the suction point.

38、The micro-droplet generation method of claim 37, wherein in step S3, the injection rate of the liquid is 1 μL/s to 10 μL/s.

39、The micro-droplet generation method of claim 37, wherein at the first end, the distance between the upper plate and the lower plate is 0-200 μm, and the included angle between the upper plate and the lower plate is greater than 0 degrees and less than 3 degrees.

~~40、The micro-droplet generation method of claim 28 or 30, characterized in that the microfluidic chip is provided with a first sample injection hole and a first sample drain hole, and the first sample drain hole and the first sample injection hole are arranged on a first diagonal of the microfluidic chip, the first sample injection hole is communicated with a first micropump, and the first sample drain hole is communicated with a third micropump;~~

~~In step S3, the liquid is injected into the fluid channel layer via the first sample injection hole using a first micropump; A third micropump is used for pumping liquid flowing out of the first sample drain hole.~~

~~41、The micro-droplet generation method of claim 40, wherein the microfluidic chip is further provided with a second sample injection hole and a second sample drain hole, the second sample drain hole and the second sample injection hole are arranged on a second diagonal line of the microfluidic chip, and the second sample injection hole is communicated with a second micropump; The second sample drain hole is communicated with a fourth micropump;~~

~~In step S4, a medium is injected into the fluid channel layer via the second sample injection hole using a second micropump; Pushing said liquid out of said suction point by said medium, said liquid leaves a micro-droplet at a location corresponding to said suction point, said medium wrapping said micro-droplet; A fourth micropump is adopted to pump the medium flowing out of the second sample drain hole.~~

~~42、The micro-droplet generating method according to any one of claims 27 to 33, wherein the volume and density of micro-droplets formed by the microfluidic chip is adjusted by controlling and adjusting the gap between the upper electrode plate and the lower electrode plate, and the number, area size and position of the suction points.~~

15~~43~~、A micro-droplet generating method is characterized by comprising the following steps of:

Providing a microfluidic chip including an upper plate and a lower plate, a fluid channel layer formed between the upper plate and the lower plate; The lower plate includes an electrode layer including a plurality of electrodes arranged in an array;

Forming a plurality of suction points in the lower plate, the suction points for adsorbing liquid; The suction point is formed by electrodes actuated by the electrode layer, and adjacent actuated electrodes are arranged at intervals through the electrodes which are not actuated;

Injecting a liquid sample into the fluid channel layer, and forming n1 droplets of the liquid sample at a position corresponding to the suction point by controlling opening and closing of the electrode;

Controlling the opening and closing of the electrode to make each of the formed n1 micro-droplets form n2 micro-droplets at the position of the suction point;

Controlling the opening and closing of the electrode to make each of the formed n2 micro-droplets form n3 micro-droplets at the position of the suction point;

Repeatedly controlling opening and closing of the electrodes to form a target number of micro-droplets;

Wherein n1, n2, n3 are positive integers greater than or equal to 2.

1644、The method of claim 1543, wherein the liquid sample is injected into the fluid channel layer, and the liquid sample forms two droplets at a position corresponding to the suction point by controlling the opening and closing of the electrode;

Controlling the opening and closing of the electrode to make each of the two formed droplets form two droplets at the position of the suction point;

Controlling the opening and closing of the electrode to make each of the two formed droplets form two droplets at the position of the suction point;

Repeatedly controlling the opening and closing of the electrodes to form a target number of micro-droplets.

1745、The micro-droplet generation method of claim 1543, wherein the liquid sample is injected into the fluid channel layer, and the liquid sample forms three micro-droplets at a position corresponding to the suction point by controlling the opening and closing of the electrode;

Controlling the opening and closing of the electrode to make each of the formed three micro-droplets form three micro-droplets at the position of the suction point;

Controlling the opening and closing of the electrode to make each of the formed three micro-droplets form three micro-droplets at the position of the suction point;

Repeatedly controlling the opening and closing of the electrodes to form a target number of micro-droplets.

1846、The method of claim 1543, wherein the liquid sample is injected into the fluid channel layer and forms four droplets at a position corresponding to the suction point by controlling the opening and closing of the electrode;

Controlling the opening and closing of the electrode to make each of the four formed droplets form four droplets at the position of the suction point;

Controlling the opening and closing of the electrode to make each of the four formed droplets form four droplets at the position of the suction point;

Repeatedly controlling the opening and closing of the electrodes to form a target number of micro-droplets.

1947、A micro-droplet generation method according to claim 1543, wherein the electrode is square or hexagonal; wherein the side length of the electrode is 50 μm to 2 mm.

2048、The micro-droplet generation method of claim 1947, characterised in that it comprises, the upper electrode plate comprises an upper plate, a conductive layer and a first hydrophobic layer which are sequentially stacked; The lower plate further comprises a second hydrophobic layer and a dielectric layer, wherein the second hydrophobic layer, the dielectric layer and the electrode layer are sequentially stacked; The first hydrophobic layer and the second hydrophobic layer are oppositely arranged, and the fluid channel layer is formed between the first hydrophobic layer and the second hydrophobic layer; wherein the distance between the first hydrophobic layer and the second hydrophobic layer is 5 μm to 600 μm.

~~49、The micro-droplet generating method of claim 47, wherein the side length of the electrode is 50 μm to 2 mm.~~

~~50、The micro-droplet generation method of claim 48, wherein the distance between the first hydrophobic layer and the second hydrophobic layer is 5 μm to 600 μm.~~