Claims

1. A method for opening the external layer structure of cells using laser, characterized by comprising;

providing an analysis cartridge (2), the analysis cartridge (2) comprising a flow channel (300) for containing a biological sample (302);

providing a laser device (3) over the analysis cartridge (2) ,the laser device (3) comprising a laser source (100) ~~which is~~for emitting a short pulse laser beam and an optical lens set (200) for improving convergence and focusing of the short pulse laser beam, wherein the laser device is configured to process the biological sample;

providing a microcontroller (4) configured to generate a plurality of signals;

providing a signal generator (5), electrically connected ~~to a~~between the microcontroller (4~~), wherein~~) and the laser source (100~~) is configured to emit a~~), wherein the signal generator (5) is configured to receive a first signal of the plurality of signals from the microcontroller (4) to adjust a repetition rate of the short pulse laser beam;

~~providing an optical lens set (200) in front of the laser source (100), with the short pulse laser beam passing through the optical lens set (200);~~

~~providing a biological sample (302), wherein the microcontroller (4) is configured to control a motion state of the biological sample (302), and the motion state of the biological sample (301) comprises a static state or a flowing state; and~~

providing a power supply (7), electrically connected between the microcontroller (7) and the laser source (100), wherein the power supply (7) is configured to receive a second signal of the plurality of signals from the microcontroller (4) to output a current to the laser source (100) and to control an output power of the short pulse laser beam; and

providing a flow rate and flow volume controller (6), electrically connected to the microcontroller (4), wherein the flow rate and flow volume controller (6) is configured to receive a third signal of the plurality of signals from the microcontroller (4) to control a motion state of a the biological sample in the flow channel (300) of the analysis cartridge (2);

wherein processing the biological sample (302) using the short pulse laser beam to ~~break cell membranes or cell walls of~~ generate shock waves to treat the biological sample (302) along with a flow of the biological sample (302) in the flow channel (300) of the analysis cartridge (2), by generating a pressure difference in cells ~~(301)~~ within the biological sample (302~~), wherein a repetition rate and a output power of the short pulse laser beam is controlled during processing the biological sample (302~~) to damage cell membrane or cell

wall thereof for breaking the cells in the biological sample (302), wherein the biological sample (302) is flowing at a fixed flow rate ranged between 0.01 and 1.5 milliliter per minute (ml/min).

2. The method according to claim 1, characterized in that the short pulse laser beam comprises a nanosecond pulse laser beam, a pulse width of the short pulse laser beam is between 1 nanosecond (ns) and 500 ns, a wavelength of the short pulse laser beam ranges from 800 nanometers (nm) to 1100 nm, a pulse energy of the short pulse laser beam ranges from 20 nanojoules (nJ) to 2000 nJ, the output power of the short pulse laser beam is between 10 watts (W) and 200 W, and the repetition rate of the short pulse laser beam is between 0.1 megahertz (MHz) and 5 MHz.

3. The method according to any one of claims 1 to 2, characterized in that the ~~motion state of the biological sample (302) is the static state, the biological sample (302) is disposed at a fixed point in a flow channel (300), and a vibrating mirror is disposed between the laser source (100) and the optical lens set (200) for emitting the short pulse laser beam onto the biological sample (302) in a two-dimensional or three-dimensional scanning mode~~flow channel (300) has a depth of 0.01 millimeter (mm) to 3 mm and a width of 0.01 mm to 3 mm.

~~4. The method according to any one of claims 1 to 2, characterized in that the motion state of the biological sample (302) is the flowing state, the biological sample (302) flows at a flow rate ranged between 0.01 milliliter per minute (ml/min) and 1.5 ml/min in a flow channel (300) having a depth of 0.01 millimeter (mm) to 3 mm and a width of 0.01 mm to 3 mm, and the short pulse laser beam is emitted onto the biological sample (302) along with the flow of the biological sample (302).~~

~~5. The method according to any one of claims 1 to 4~~4. The method according to any one of claims 1 to 3, characterized in that the laser source (100) is selected from a group consisting of a semiconductor laser, a solid-state laser and a fiber laser, and a material of the laser source (100) is selected from a group consisting of neodymium yttrium aluminum garnet (Nd YAG), indium gallium arsenide/aluminum gallium arsenide((In)Ga(Al)As/AlGaAs), aluminum gallium indium arsenide (InGaAlAs), and indium gallium phosphide arsenide (InGaAsP).

~~6~~5. The method according to any one of claims 1 to ~~5~~4, characterized in that the optical lens set

(200) is configured to converge the short pulse laser beam, and a spot size of a focus (107) of the short pulse laser beam is between 0.1 mm and 5.1 mm in diameter, and the semiconductor laser comprises a laser diode.

~~7~~6. The method according to any one of claims 1 to ~~6~~5, characterized in that the biological sample (302) comprises a tissue of animal or plant, a cell of animal or plant, a microbial cell, or a sample suspected to contain biological tissues or cells (301).

~~8~~7. An apparatus (1) for opening the external layer structure of cells using laser, characterized by comprising:

an analysis cartridge (2), comprising a flow channel (300), wherein the flow channel (300) comprising a biological sample (302) disposed therein;

a microcontroller (4~~);~~), configured to generate a plurality of signals;

a laser device (3), disposed over the analysis cartridge (2) and comprising ~~an optical lens set (200) and~~ a laser source (100) for emitting a short pulse laser beam and an optical lens set (200) for improving convergence and focusing of the short pulse laser beam;

a signal generator (5), electrically connected between the microcontroller (4) and the laser source (100), wherein the signal generator (5) is configured to receive a first signal from the microcontroller (4) to adjust a repetition rate of the short pulse laser beam;

a power supply (7), electrically connected between the microcontroller (4) and the laser source (100), wherein the power supply (7) is configured to receive a second signal from the microcontroller (4) to output a current to the laser source (100) and to control an output power of the short pulse laser beam; and

a flow rate and flow volume controller (6), electrically connected to the microcontroller (4), wherein the flow rate and flow volume controller (6) is coupled to the analysis cartridge (2) and configured to receive a third signal from the microcontroller (4) to control a motion state of a biological sample (302) ~~comprising cells (301) or suspected to contain cells (301~~in the flow channel (300), wherein the short pulse laser beam is converged when passing through the optical lens set (200), and then is focused on a focus (107), and the biological sample (302) is subjected to the short pulse laser beam, so that cell membranes or cell walls of cells (301) in the biological sample (302) are broken~~.~~ by the short pulse laser beam to generate shock wave, wherein in that a depth of the flow channel (300) is raged between 0.01 mm and 3 mm and a width of the flow channel (300) is ranged between 0.01 mm and 3 mm, and a flow rate of the biological sample (302) is ranged between 0.01

and 1.5 milliliter per minute (ml/min).

~~9~~8. The apparatus (1) according to claim ~~8~~7, characterized in that the short pulse laser beam comprises a nanosecond pulse laser beam, a pulse width of the short pulse laser beam is between 1 nanosecond (ns) and 500 ns, a wavelength of the short pulse laser beam ranges from 800 nanometers (nm) to 1100 nm, a pulse energy of the short pulse laser beam ranges from 20 nanojoules (nJ) to 2000 nJ, the output power of the short pulse laser beam is between 10 watts (W) and 200 W, and the repetition rate of the short pulse laser beam is between 0.1 megahertz (MHz) and 5 MHz.

~~10~~9. The apparatus (1) according to ~~any one of claims~~claim 7 or 8 ~~to 9~~, characterized in that the laser device (3) further comprises a vibrating mirror disposed between the laser source (100) and the optical lens set (200~~), the biological sample (302) is located at a fixed point in a flow channel (300) when the motion state is at a static state, and the vibrating mirror is configured to emit the short pulse laser beam onto the biological sample (302) via the optical lens set (200) in a two-dimensional or three-dimensional scanning mode.~~).

~~11. The apparatus (1) according to any one of claims 8 to 9, characterized in that the flow rate and flow volume controller (6) is coupled to an analysis cartridge (2), and which is configured to receive the third signal to inject the biological sample (302) into a flow channel (300) of the analysis cartridge (2), and is configured to drive the biological sample (302) to flow at a flow rate ranged between 0.01 milliliter per minute (ml/min) and 1.5 ml/min in the flow channel (300) having a depth of 0.01 millimeter (mm) to 3 mm and a width of 0.01 mm to 3 mm to be treated with the short pulse laser beam along with the flow.~~

~~12. The apparatus (1) according to any one of claims 8 to 11~~10. The apparatus (1) according to any one of claims 7 to 9, characterized in that a spot size of the focus (107) of the short pulse laser beam is between 0.1 mm and 5.1 mm in diameter, and the semiconductor laser comprises a laser diode.

~~13~~11. The apparatus (1) according to any one of claims ~~8~~7 to ~~12~~10, characterized in that the optical lens set (200) comprises a light receiving lens (210) and a focusing lens (230), wherein a numerical aperture of the light receiving lens (210) is ranging from 0.2 to 0.55 and a numerical aperture of the focusing lens (230) is ranging from 0.2 to 0.55.

~~14~~12. The apparatus (1) according to claim ~~13~~11, characterized in that the light receiving lens (210) comprises a short-focus lens, and the focusing lens (230) is selected from a group consisting of an aspheric lens, an objective lens, a spherical lens, a diffractive optical element and a non-curved lens.

~~15~~13. The apparatus (1) according to any one of claims ~~8~~7 to ~~14~~12, characterized in that the flow rate and flow volume controller (6) is selected from a group consisting of a syringe pump, a cylinder-type power pump, a quantitative liquid pump and a micro gas pump.