

rapid diagnosis of bacterial infection and antibiotic resistance since overnight culturing is first performed to obtain pure species-specific bacterial colonies from which DNA is extracted.

[0014] Lastly, newer sequencing technologies may substantially reduce sequencing time, but the costs associated with purchasing these machines and running the assays remain high.

5 [0015] There is therefore a need to provide a device and system that overcomes, or at least ameliorates, one or more of the disadvantages described above. There is a need for a rapid, high-throughput and accurate method of detecting target molecules.

SUMMARY OF THE DISCLOSURE

10 [0016] There is provided a microfluidic device comprising: a plurality of wells, each well having an inlet and an outlet, wherein the inlets are in fluid communication with one or more entry channels and the outlets are in fluid communication with one or more exit channels, wherein said outlet is connected to the exit channel via an outlet connecting channel and said inlet is connected to the entry channel via an inlet connecting channel wherein the dimension
15 of the outlet connecting channel is configured such that the surface tension of a liquid comprised in the well prevents the release of the liquid through the outlet connecting channel.

[0016a] In a first aspect, there is provided a microfluidic device comprising: a plurality of wells, each well having an inlet and an outlet, wherein the inlets are in fluid communication with one or more entry channels and the outlets are in fluid communication with one or more
20 exit channels, wherein said outlet is connected to the exit channel via an outlet connecting channel and said inlet is connected to the entry channel via an inlet connecting channel wherein the dimension of the outlet connecting channel is configured such that the surface tension of a liquid comprised in the well prevents the release of the liquid through the outlet connecting channel, wherein the outlet connecting channel comprises a converging zone, said
25 converging zone having an inclined surface connecting a base of the well with said outlet connecting channel; wherein a side wall of said converging zone forms an angle (a) with a longitudinal axis through the outlet connecting channel; wherein the inclined surface of said converging zone forms an angle (b) with the bottom of the outlet connecting channel; and wherein angle (a) is between 30° to 60° and (b) is between 40° to 70°.

[0017] In a second aspect, there is provided a system comprising: a microfluidic device as disclosed herein; and a detection device arranged above or below the microfluidic device for detecting a signal emitted by the possible reaction products comprised in the wells during use.

- 5 [0018] In a third aspect, there is provided a method of detecting at least one target molecule from a liquid sample using the system as disclosed herein, wherein the method sequentially comprises: filling the plurality of wells with the liquid sample by pumping the liquid sample from the source comprising the possible target molecule into the entry channel at a flow rate selected to allow inflow of the liquid sample into the plurality of wells while
10 avoiding release of the liquid into the exit channel, removing excess liquid in the entry channel by pulling a vacuum from the vacuum source connected to the entry channel, pumping sealant into the entry channel followed by pumping sealant into the exit channel to thereby isolate the liquid sample in each well, and detecting a possible signal emitted by a reaction product between the target molecule and the detection probe.

[0019] There is also provided the use of the system as disclosed herein in the detection of bacteria resistant against at least one antibacterial agent.

BRIEF DESCRIPTION OF THE DRAWINGS

5 [0020] The invention will be better understood with reference to the detailed description when considered in conjunction with the non-limiting examples and the accompanying drawings, in which:

[0021] **Fig. 1a** shows an illustration of the top view of each well according to a specific example of the present disclosure. **Fig. 1b** shows an illustration of the cross-sectional view of the well in the disclosed microfluidic device 100. **Fig. 1c** shows an illustration of the top view of well 102 connected to exit channel 108 via outlet connecting channel 106 comprising a converging zone.

[0022] **Fig. 2** shows an illustration of the top view of part of the disclosed device according to a specific example of the present disclosure.

15 [0023] **Fig. 3** shows an illustration of the cross-sectional view of molecular beacon probes 150 loaded in each well 102 according to a specific example of the present disclosure.

[0024] **Fig. 4a** shows an illustration of the device 100 according to a specific example of the present disclosure where the plurality of wells 102 is arranged in a circular configuration. **Fig. 4b** shows an illustration of the device 100 according to another specific example of the present disclosure where the plurality of wells 102 is arranged in a square configuration.

25 [0025] **Fig. 5A** shows an image of the disclosed device when adhesive is used. The image demonstrates that fluorescence can be seen where adhesive is used, in addition to the source and within the wells and channels. **Fig. 5B** shows an image of the disclosed device having black tape covering the area where adhesive was placed, evidencing that the black tape effectively reduces the autofluorescence previous emitted by the adhesive.

[0026] **Fig. 6** shows an illustration of the system 300 in accordance with a specific example of the present disclosure.

30 [0027] **Fig. 7a** shows a schematic of the light insulator 350 in accordance with an example of the present disclosure. **Fig. 7b** shows a photograph of a prototype of the optical system that incorporates the light insulator 350. **Fig. 7c** shows a schematic of the beam of light in a circular pattern from the light source incident on the plurality of wells on the microfluidic device.

Claims

1. A microfluidic device comprising:

a plurality of wells, each well having an inlet and an outlet, wherein the inlets are in fluid communication with one or more entry channels and the outlets are in fluid communication with one or more exit channels,

wherein said outlet is connected to the exit channel via an outlet connecting channel and said inlet is connected to the entry channel via an inlet connecting channel wherein the dimension of the outlet connecting channel is configured such that the surface tension of a liquid comprised in the well prevents the release of the liquid through the outlet connecting channel,

wherein the outlet connecting channel comprises a converging zone, said converging zone having an inclined surface connecting a base of the well with said outlet connecting channel;

wherein a side wall of said converging zone forms an angle (a) with a longitudinal axis through the outlet connecting channel;

wherein the inclined surface of said converging zone forms an angle (b) with the bottom of the outlet connecting channel; and

wherein angle (a) is between 30° to 60° and (b) is between 40° to 70°.

2. The device of claim 1, wherein the device comprises a single entry channel and optionally a single exit channel, wherein the single entry channel connects all inlets with each other and the optional single exit channel connects all outlets with each other.

3. The device of claim 1, wherein each well comprises a detection probe, and the detection probe is optionally a lyophilized detection probe.

4. The device of claim 3, wherein the detection probe in each well binds specifically to a different target molecule, and the target molecule is the product of an amplification reaction.

5. The device of claim 1, wherein the plurality of wells is arranged on the device in a radially symmetrical pattern.

6. The device of claim 1, wherein the dimension of the outlet connecting channel is between 0.05 to 3 mm by between 0.05 to 3 mm, or between 0.2 mm by 0.2 mm.
7. The device of claim 1, wherein the volume of each well is independently selected to be between 1 to 10 μ l.
8. The device of claim 1, wherein the plurality of wells is in the range of between 2 to 100, or 5 to 100, or 5 to 50.
9. The device of claim 1, wherein the entry channel is in fluid communication with any one of the following: a vacuum source connected to a first end of the entry channel or a vacuum source connected to a first end of the entry channel via a liquid trap, a sealant source connected to a second end of the entry channel, a gas source connected to the second end of the entry channel and a source comprising a possible target molecule connected to the second end of the entry channel, and the exit channel is in fluid communication with any one of the following: a vacuum source connected to a first end of the exit channel or a vacuum source connected to a first end of the exit channel via a liquid trap and a sealant source connected to a second end of the exit channel.
10. The device of claim 9, wherein the connection to the sources is controlled by one or more valves which can be controlled separately.
11. The device of claim 1, wherein the material covering or forming the top or top and bottom of the well is made of a transparent material while the remaining device is made of a translucent material.
12. A system comprising:
- a device of claim 1;
 - a detection device arranged above or below the device for detecting a signal emitted by the possible reaction products comprised in the wells during use.
13. The system of claim 12, further comprising one or more of:
- a sealant source connectable to the device to be in fluid communication with the entry channel and/or exit channel,

a gas source connectable to the device to be in fluid communication with the entry channel,

a source comprising a possible target molecule connectable to the device to be in fluid communication with the entry channel, and

a vacuum source connected to the exit and/or entry channel or a vacuum source connected to the exit and/or entry channel via a liquid trap.

14. The system of claim 12, wherein the plurality of wells is arranged to be in thermal communication with a heating element, and the detection device is further capable of emitting a signal for exciting the possible reaction product comprised in the well.

15. A method of detecting at least one target molecule from a liquid sample using the system of claim 12, wherein the method sequentially comprises:

- filling the plurality of wells with the liquid sample by pumping the liquid sample from the source comprising the possible target molecule into the entry channel at a flow rate selected to allow inflow of the liquid sample into the plurality of wells while avoiding release of the liquid into the exit channel,
- removing excess liquid in the entry channel by pulling a vacuum from the vacuum source connected to the entry channel,
- pumping sealant into the entry channel followed by pumping sealant into the exit channel to thereby isolate the liquid sample in each well, and
- detecting a possible signal emitted by a reaction product between the target molecule and the detection probe.

16. The method of claim 15, wherein the plurality of wells are sequentially filled with the liquid sample, and the liquid sample is pumped at a flow rate of between 10 mL/h to 120 mL/h, or 10 mL/h to 100 mL/h.

17. The method of claim 15, wherein the target molecule is the reaction product of an amplification reaction, preferably an asymmetric polymerase chain reaction (PCR).

18. The method of claim 15, wherein the pumping of sealant into the entry channel is at a flow rate of between 10 mL/h to 40 mL/h, and the pumping of sealant into the exit channel is at a flow rate of between 10 mL/h to 80 mL/h.

5 19. The method of claim 15, wherein the sealant is liquid wax.