Electronic Supplementary Material (ESI) for Lab on a Chip.

Rapid Detection of Hendra Virus Antibodies: An Integrated Device with Nanoparticle Assay and Chaotic Micromixing

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Automated liquid handling and assay procedures

One of the key features of the device is the automated liquid handling which allow the assay to be performed without manual intervention. The fluid handling module consists of liquid reservoirs, small solenoid valves, a vacuum pump, an air chamber and the tubing for connection with the microfluidics chip. The vacuum pump generates negative pressure, which creates a suction force that is the driving force for the liquid transport. The liquid reservoirs include a washing buffer, sensors and a substrate. One of the liquid reservoirs contains magnetic nano-particles which act as a sensing platform. Each fluid reservoir is connected to the mixing/reaction chamber through normally closed solenoid valve. This module may operate in fully automated mode.

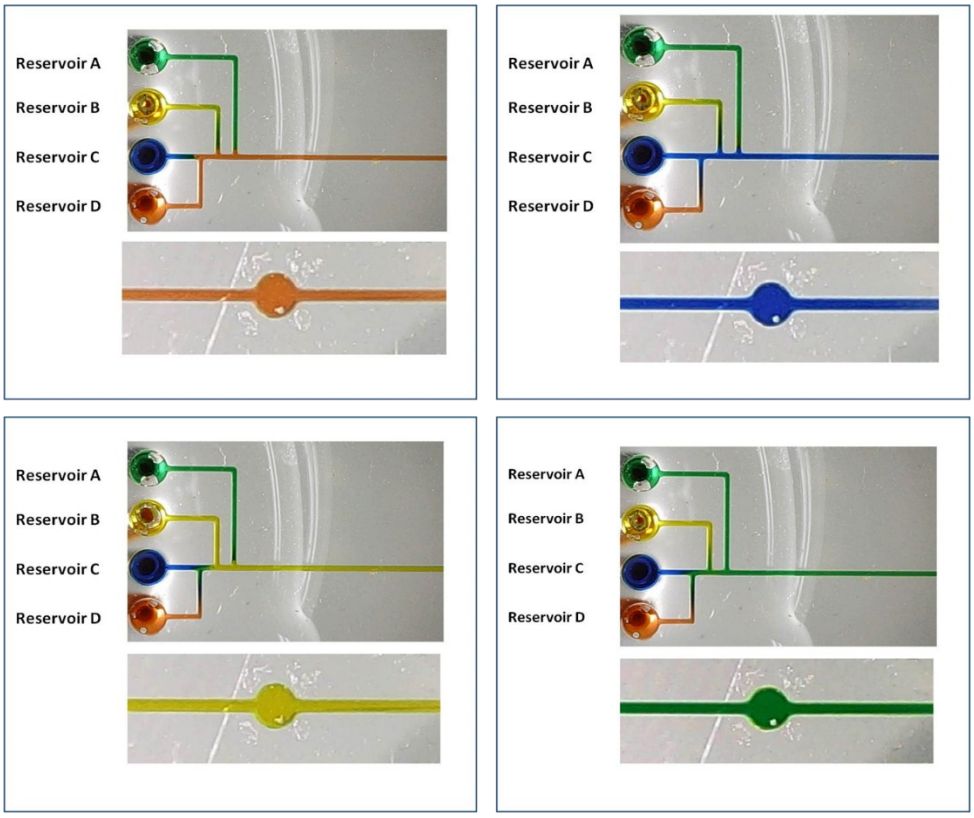

Figure 1s Automated and sequential delivery of four different model liquids into the mixing chamber. Top left: Liquid D only; Top right: Liquid C only; Bottom left: Liquid B only; Bottom right: Liquid A only;

This module can realise an automated and a sequential delivery of different liquids into the mixing chamber. For example, opening of the valve connected to the reservoir D delivers the “red liquid” into the reaction chamber (Top left image of Figure 1s). By closing the valve connected to the reservoir D and opening the one connected to the reservoir C, the “blue liquid” is delivered into the reaction chamber. Similar logic applies for the “yellow” and the “green liquids”. In addition, this fluid handling module is capable of simultaneous delivery of the two different liquid types (Figure 2s). The flow is laminar and the liquids do not mix during the delivery into the mixing chamber without activation of the micromixer.

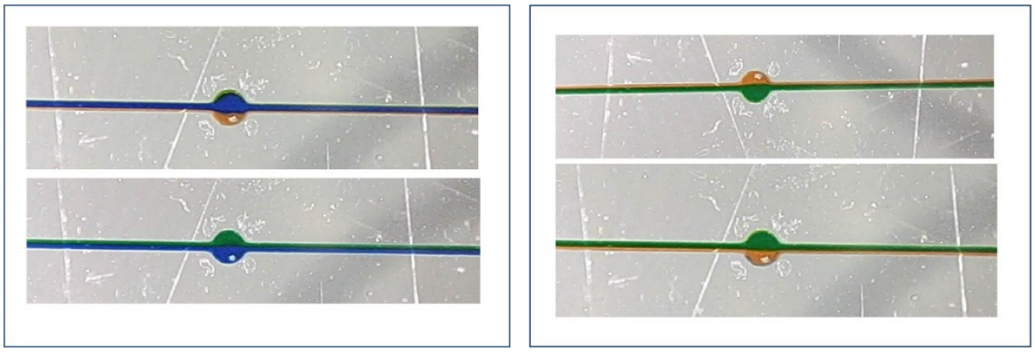

Figure 2s Simultaneous delivery of the two different liquids into the mixing chamber (split flow)

ELISA Assay Procedure

The main operating procedures are:

1) Reagent and sample loading -- placing reagent and sample vials into the device;
2) Microchip loading -- placing the microchip onto the chip holder, sliding into the device and locking the microchip into position;
3) Performing assay –
    a) Priming: pumping the washing buffer (Reagent A) to the microchamber and all microchannels; Sample loading: both Sample and Reagent B (MB solution) solutions are pumped into the microchip to expel the washing buffer and fill the main chamber with the two solutions;
    b) Mixing: switch on and off of the magnetic pins in a predefined pattern to induce chaotic mixing of the two solutions (for HeV antibody to bind with the sG protein attached to MB);

c) Washing: switch off mixing and activate one or two pins to hold the MB in the chamber and then pumping the washing buffer to wash off all spent solutions;
d) Label loading: with MB held in position, pumping Reagent C (fluorescent label solution) into the chamber;
e) Mixing: repeat step 3 for labelled protein to bind to HeV antibody;
f) Washing: pumping buffer solution again to the chamber to wash off all spent solutions.

4) Fluorescence detection and data collection.
5) Microchip removal and disposal.

Video 1

Sequential delivery of fluids from liquid reservoirs to the mixing chamber.

Video 2

Chaotic magnetic micromixing. The magnetic pins A,B,C,D are respectively turned ON and OFF.