All-polymer chip system for magnetic bead-based solid phase extraction

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Paramagnetic particles or magnetic beads (MBs) are commonly used as the solid phase matrix for magnetic bead-based solid phase extraction (SPE). A variant of MB-based SPE exists, where an immiscible phase is used as a filtering step in order to circumvent the washing steps otherwise needed to perform a variant extraction [1-3]. The principle of the technology is presented in the sketch below.

In this study we present an injection moulded cyclic olefin copolymer (COC) planar chip system that has been bonded together using ultrasonic welding – both techniques that can be readily applied in mass production and it is what sets this system apart from ones previously published. The chip is fitted with geometric capillary micro valves for MB-based SPE using the immiscible phase filtration approach. See figure 1 for a photograph of the chip.

We

- Characterise the chip in regard to carry-over volume and further investigate the influence of surfactants on the efficacy of the system.
- Present initial performance results, by detecting respiratory syncytial virus (RSV) in a mucus sample.

## Results

The chip was performance tested in regard to volume carry-over and ability to detect RSV. The chip was tested with various surfactants and the carry-over volume was quantified.

Figure 2 shows the determination of volume carry-over vs. amount of MyOne SILANE magnetic beads for pure water and a typical TNA lysis/binding buffer. We find that the volume carry-over;

- is proportional to the amount of beads through a linear correlation.
- is the same for Milli-Q water and the typical lysis/binding buffer.

Figure 3 shows initial results on RNA extraction, comparing the on-chip assay with an off-chip reference.

We find that;

- Reducing the MB amount to one compatible with the chip had no effect on Cq.
- The on-chip extraction performed on par with the off-chip extraction.

## Conclusion/Outlook

We have demonstrated a mass-producible all-polymer chip created for Mb-based solid phase extraction via immiscible phase filtration. It shows a low volume carry-over and is capable of extracting viral RNA from a mucus sample. Future studies include a more thorough investigation of RNA extraction and a possible switch in polymer type for chip manufacturing. The COC used here is not optimal for a system where you wish to employ surfactants. A polymer with improved surfactant properties is recommended.

## Methods

### Volume carry-over quantification

A suspension containing solution was added to the inlet channel and a blank solution to the outlet chamber. FC40 oil was then added to the middle chamber to complete the volume calibration. Various volumes of MBs were then added to the inlet and transferred from one channel to another by moving the magnet. The MBs were then washed twice with Milli-Assist (Milli-Q water) and finally transferred to the outlet chamber for measurement.

### Off-chip extraction protocol

100 µl of mucus sample (dissolved in salt water) was added to a 1.5 ml tube, mixed by pipetting, and left to incubate at RT for 10 min. The beads were then washed twice with Milli-Assist, and finally transferred to the outlet chamber and eluted at 70 °C for 5 min.

### On-chip extraction protocol

100 µl of mucus sample was added to a 1.5 ml tube, mixed by pipetting, and left to incubate at RT for 10 min. The solution was then transferred to the “inlet” chamber of the chip, which had been pre-loaded with 50 µl 10 mM TE buffer in the “outlet” chamber. 50 µl FC40 oil was then added to the “outlet” chamber, which had been pre-loaded with 50 µl 10 mM TE buffer in the “outlet” chamber. The chip was then loaded onto the chip carrier using the external magnet and the contents of the elution chamber were transferred to a 1.5 ml tube and eluted at 70 °C for 5 min.