A Centrifugal Microfluidic Platform Using SLM Extraction
for combined sample clean-up and enrichment of trace analytes

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A Centrifugal Microfluidic Platform Using SLM Extraction - for combined sample clean-up and enrichment of trace analytes

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Here we present a pump-less microfluidic platform which performs sample clean-up and enrichment in a single step, by integrating Supported Liquid Membrane (SLM) extraction. Our platform offers a simple, yet very efficient, method for achieving sample pre-treatment and enrichment of rare analytes, in an easy to use and highly efficient device.

**Working principle: Separating & trapping of weak acids (or bases)**

Experimental setup for the SLM extraction process is shown. The donor channel contains the sample to be extracted, while the acceptor channel contains the stripping solution. The spinning motion is used to drive liquid flow, and the centrifugal force helps to concentrate the extracted species in the acceptor channel.

**Example:** pH trapping of p-coumaric acid

The pH trapping process is illustrated with the example of p-coumaric acid. The trapping efficiency is shown as a function of pH, with a peak at pH 7, indicating that p-coumaric acid is efficiently trapped at this pH.

**On-disc flow control: A challenge!**

In order to have efficient and reproducible SLM extractions, a good and reliable control of the microfluidic flow is needed. However, centrifugal pumping cannot be controlled directly, but only indirectly, through the rotational speed of the disc, which can vary due to different factors. This can affect the flow rate and thus the extraction efficiency.

**Flow chips for testing extraction during flow:**

These chips are designed to test the extraction efficiency during flow. The chips have channels with different dimensions and flow rates, allowing for the optimization of the extraction process.

**On-disc extraction w. enrichment:**

An alternative method to achieve high enrichment factors is to use a centrifugal platform with a combination of the SLM extraction and a passive extraction step. This method allows for the concentration of trace analytes in a small volume, which is particularly useful for trace analysis applications.

**Real application:**

Screening production of genetically modified bacteria strains.

**Bacteria supernatant w. both compounds:**

The supernatant of bacteria cultures containing both p-coumaric acid and tyrosine is shown here. The concentration of the analytes is measured using UV-Vis spectroscopy.

**Bacteria supernatant w. one compound:**

The supernatant of bacteria cultures containing only one compound (either p-coumaric acid or tyrosine) is shown here. The concentration of the analytes is measured using UV-Vis spectroscopy.

**SLM extraction from pure samples & mix:**

The SLM extraction process is demonstrated with both pure samples and mixtures. The extraction efficiency is shown as a function of pH, with a peak at pH 7, indicating that p-coumaric acid is efficiently trapped at this pH.

**Other small molecules tested and used for SLM extraction (Neutral (no charge) at low pH):**

Penicillin G and Theophylline are examples of small molecules that can be extracted using SLM.

Alternative tactics for achieving even more specific trapping:

1. Immuno-SLM: Using antibodies to specifically bind to the target analyte.
2. Supported membranes with organic solvents (25 µm thick).

Theophylline adsorption is shown here, where the analyte is efficiently trapped in the acceptor channel.

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