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
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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)

**EXPERIMENT START:** Non-porous extraction of analyte: only small molecules, on their neutral form, can pass through the oil film, separating the donor fluid from a stagnant acceptor buffer. The oil is kept in place by a 25 µm thick non-porous polypropylene membrane.

**EXPERIMENT ONGOING:** By choosing a pH above (below) the pKₐ of the acid (base) in the acceptor buffer, the analyte is trapped. While continuing to replenish the donor, both separation and enrichment of the target analyte is possible.

Real application: Screening production of genetically modified bacteria strains:

E. Coli bacteria genetically modified to convert tyrosine to p-coumaric acid (an important precursor for a number of drugs) to achieve better productivity and a higher selectivity. The bacteria is able to distinguish between the two compounds. Both compounds can be detected by electrophoresis, but unfortunately the selectivity of the two compounds is too overlapping (see figure below). In large-scale measurements difficult in this case. Using this workflow we were able to separate the two compounds in 30 minutes.

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

<table>
<thead>
<tr>
<th>pH</th>
<th>Donor channel: Aqueous media</th>
<th>Accepter channel: Aqueous media</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Penicillin G</td>
<td>Theophylline</td>
</tr>
<tr>
<td>7</td>
<td>De-protonized form (and acquire charge) when pH &gt; pKₐ</td>
<td></td>
</tr>
</tbody>
</table>

Alternative tactics for achieving even more specific trapping:

Immuno-SLM

In order to have efficient and reproducible SLM extractions a good and reliable control of the microfluidic flow is needed. Immuno-SLM extraction where centrifugal pumping cannot be used directly, but only indirectly, through the rotational speed of the disc, several factors are affecting the observed flow-rate. For instance, the centrifugally induced pressure needs to overcome the surface tension of the liquid. This is an ample amount, where a certain centrifugal speed is necessary to start a flow, but as soon as the flow has finally started the flow should be slowed down as possible (see figure below).

Flow chips for testing extraction during flow:

On-disc extraction w. enrichment:

**SLM extraction using flow chip**

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

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