Portable systems for real samples manipulation and analysis

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Point of care diagnostics

www.ratp.fr

www.grandcare.com/

Toutlecine.challenges.fr

www.microtrace.de
The ideal portable system

- integration
- autonomous system
- low power consumption
- portability / on site testing
- smaller sample volumes
- faster kinetics

Sample preparation (filtration, metering)

Actuation (integrated pump)

Sample processing:
- Reagent storage and delivery
- Chemical extraction
- Analyte preconcentration
- Droplet generation
- Etc...

Detection (Light source and photodetector, other biosensing methods)

Communication (CMOS, wireless, LCD...)
Sample preparation: Blood filtration

• Diagnostic device based on biosensor technology

• Inexpensive hybrid polymer material

• Plasma separation from whole blood (dead-end filtration)

• Small blood volume (few drops)

A. Homsy, et al., Biomicrofluidics 2012
Sample preparation: Blood filtration

- Blood volume: 100 µL, 40 mBar
- Plasma recovered volume: 8-15 µL
- Filtration time: 7 min

- Clinical study > 100 samples tested
  ➢ Contant recovery

Filtration time with capillary flow: (without external pressure) $t > 30$ min

A. Homsy, et al., *Biomedical Microdevices* 2012
Integrated system: Cocaine in saliva

- Microfluidic system for Near- and Mid- infrared (IR) Analysis of Human Saliva

- Molecular extraction from saliva to IR-transparent solvents

- Goal: Build an integrated system for cocaine detection by IR-spectroscopy

Schematic of droplet-based liquid-liquid extraction of cocaine from human saliva to IR-transparent tetrachloroethylene (PCE).

http://www.nano-tera.ch/projects/80.php
J-C Chang et al., LOC 2012.
Integrated system: Cocaine in saliva

- Continuous and passive microfluidic design

Channel cross section:

Saliva
PCE
Cocaine

Integrated system: Cocaine in saliva

- Molecular extraction by generating droplets
- Simple design, suitable for handling saliva
- Monodisperse droplet generation
- Droplet size ~ 4 times channel height

P. Wägli et al., Analytical Chemistry, 2013
Integrated system: Cocaine in saliva

- Passive droplet merging device
- Merging based on design
- Fluids direction of flow driven by surface properties

P. Wägli et al., Analytical Chemistry, 2013
Integrated system: Cocaine in saliva

- Simple fabrication of the microfluidic device
- Integration with infrared (IR) waveguide
- Real time measurement of cocaine in saliva with the integrated IR microfluidics system

P. Wägli et al., in Analytical Chemistry 2013
P. Jouy et al. Analyst, 2014
Fabrication methods: Surface modification

- **Chemical:**
  - Silanisation (HMDS, APTES, FOTS, etc.)
  - Self-assembling monolayer
  - Polymer bulk modification (ex. drop silane in UV glue)
  - Bio-surfaces (protein immobilization)

- **Physical:**
  - Surface roughness modification
  - Thin film coating

- **Physico-chemical:**
  - Ion implantation

*P. Wägli et al., Sensors & Actuators B: Chem., 2011*
Fabrication method: solid-on-liquid (SOLID)

Monolayer of Parylene

Later: stable coating by a solid layer

J. Charmet et al., Thin solid films 2010
SOLID encapsulated microstructures

Liquid patterning combined with Parylene C encapsulation

A. Homsy et al., review submitted to Microelectronic engineering 2014
SOLID Membranes and microchannels

Parylene-based microchannel using sacrificial liquids

A. Homsy et al., review submitted to Microelectronic engineering 2014
Commercialization of portable systems

- No user intervention
- Results available on site (< 15 min)
- Require only a finger-stick of whole body fluid
- Capability for quantitative analysis of blood, serum, urine, and other bodily fluids... even breath?

Presented today by the companies:
- One drop diagnostics
- Mycartis
Thank you for your attention!