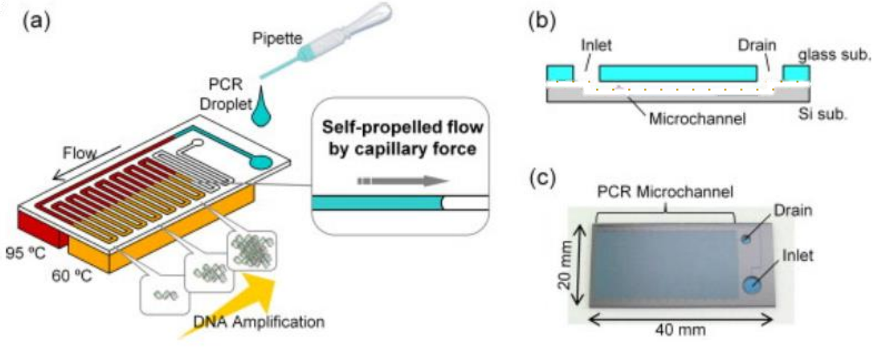
Microfluidic systems for heavy metal sensing

Introduction

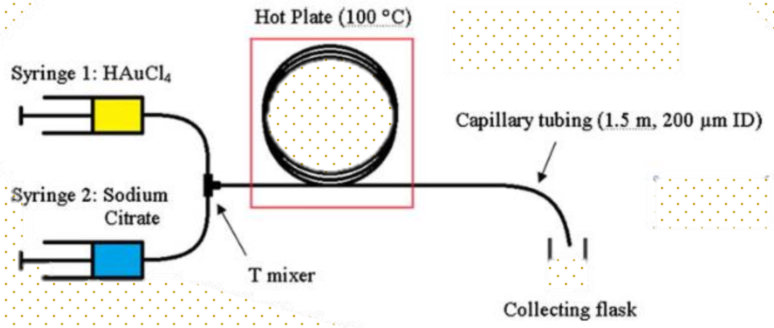
Microfluidics devices applications

MICROFLUIDIC DEVICE FOR SELF-PROPELLED CONTINUOUS-FLOW PCR



Sensors and Actuators B: Chemical
Volume 206, January 2015, Pages 303-310

SYNTHESIS OF GOLD NANOPARTICLES



Microsyst Technol (2012) 18:151–158

MULTISTEP CONTINUOUS-FLOW MICROCHEMICAL SYNTHESIS INVOLVING MULTIPLE REACTIONS AND SEPARATIONS

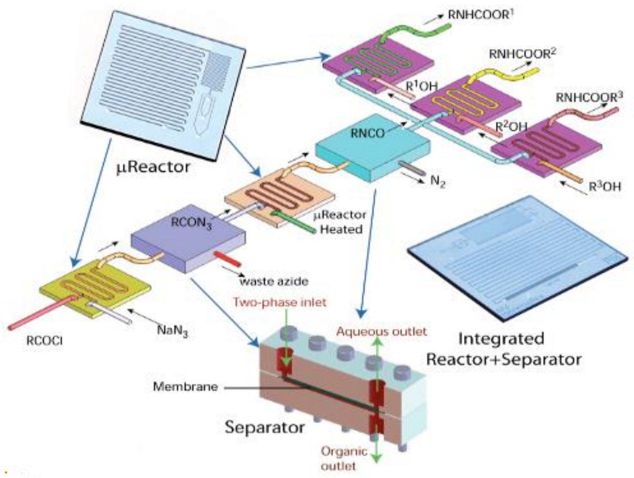
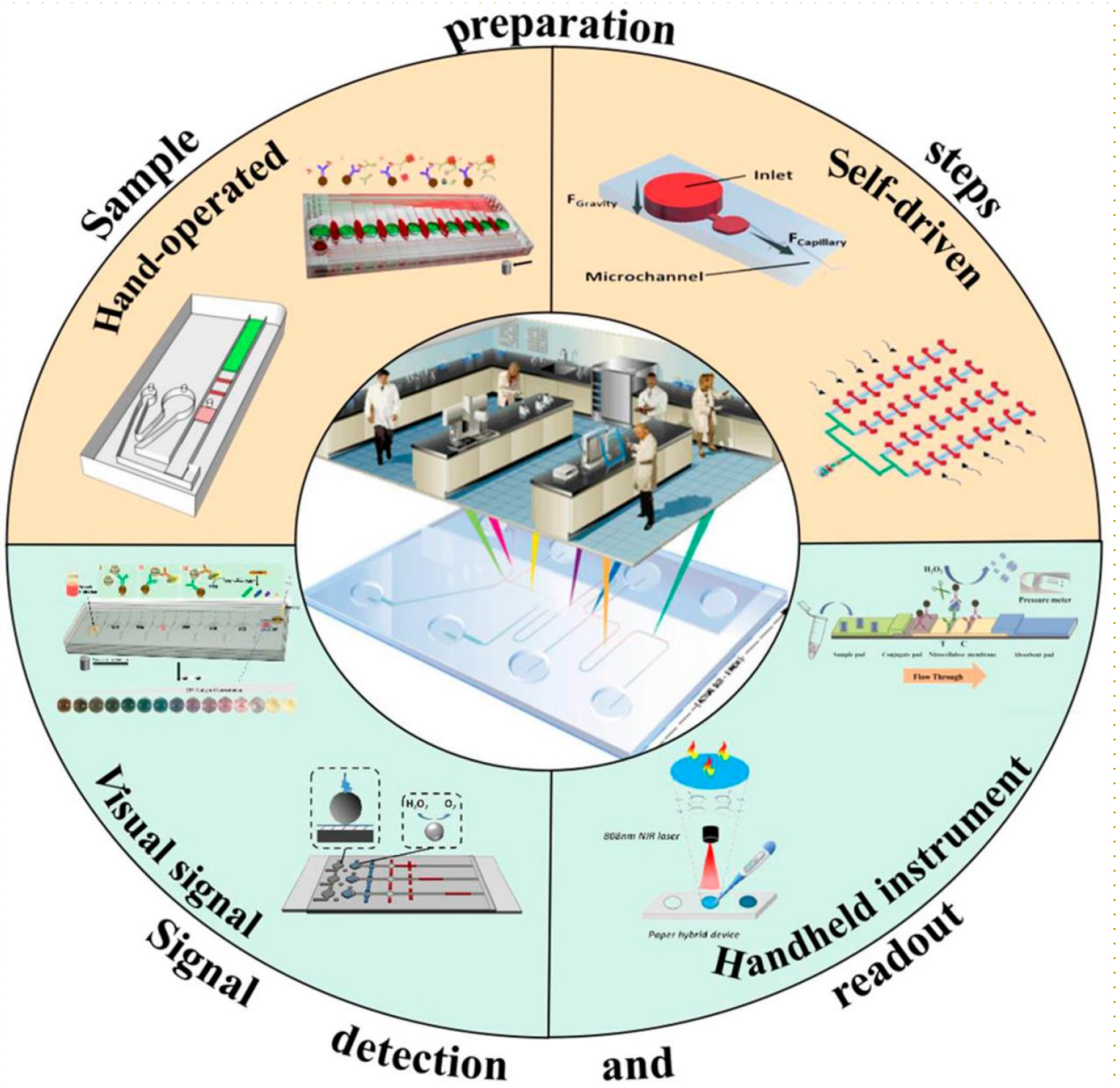


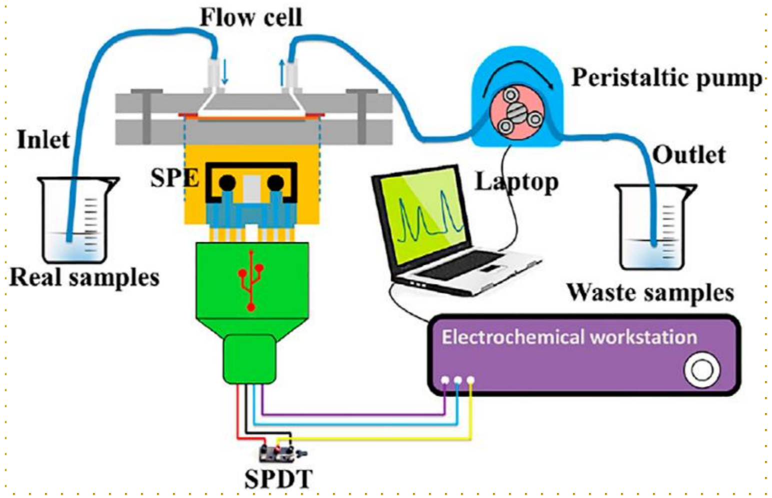
Figure 1. Multi-step microfluidic chemical synthesis of carbamates starting from aqueous azide and organic acid chloride using the Curtius rearrangement reaction. The scheme involves three reaction and two separation steps.

Angew. Chem. Int. Ed. 2007, 46, 5704.

Introduction

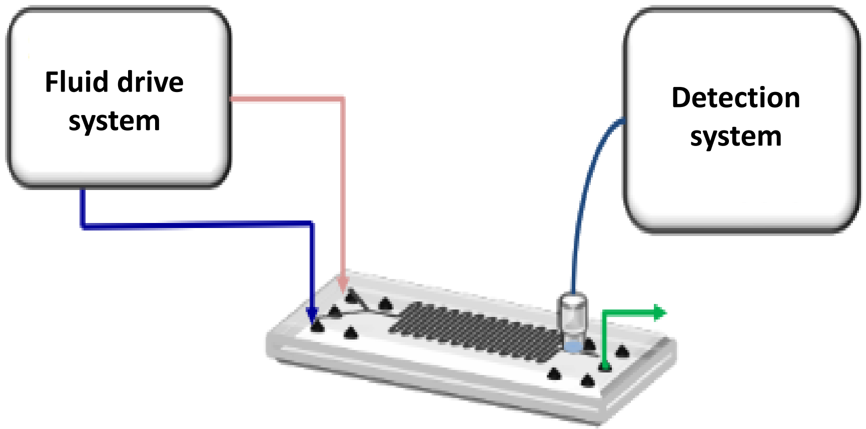


Microfluidics devices for heavy metal sensing



Micromachines **2023**, *14*(8), 1520; https://doi.org/10.3390/mi14081520

What is a microfluidic system?

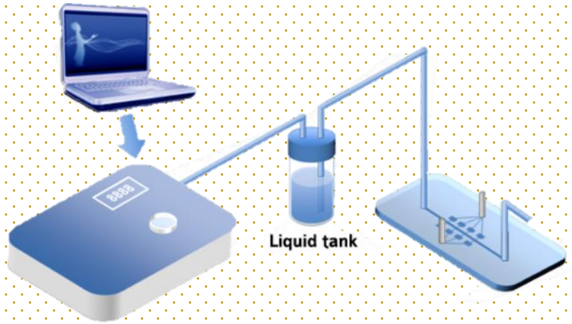


- ❑ **Positive pressure hydrodynamic drive**
- ❑ **Electroosmotic drive**
- ❑ **Electromagnetic drive**

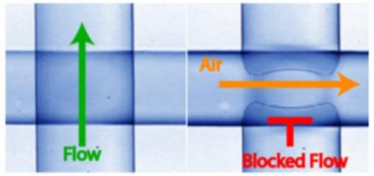
- ❑ **Mixers**
  - **Lamination-based micromixers**
  - **Micromixers Chaotic advection-based**
  - **Micromixers based on convergence-divergence structures**
  - **Micromixers based on curved channels**

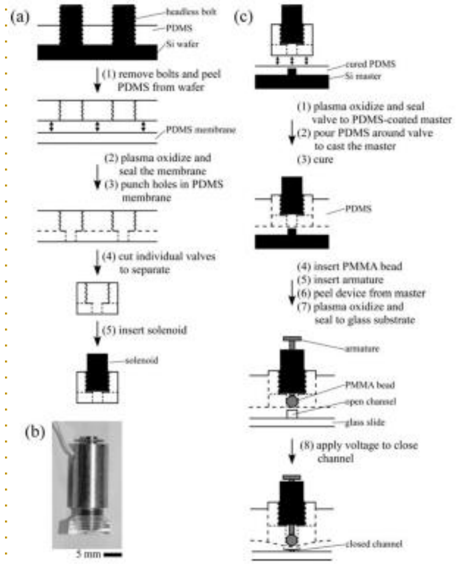
- ❑ **Optical detection**
  - Fiber optic guides
  - Epifluorescence
  - Laser-induced fluorescence
- ❑ **Electrochemical detection**
  - Potentiometric
  - Voltammetric
  - Conductimetric
- ❑ **Mass spectrometry**
- ❑ **Other types of detection**

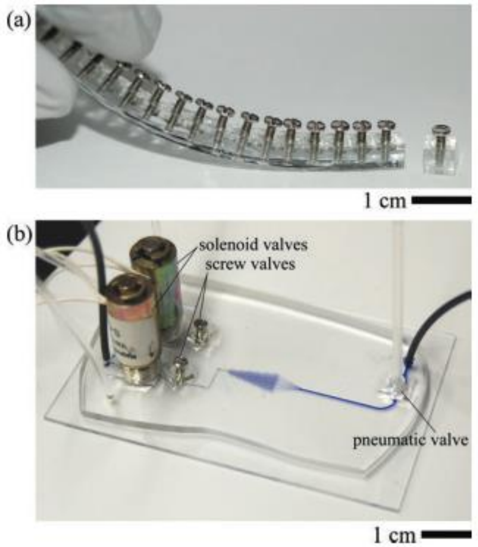
Positive pressure hydrodynamic drive

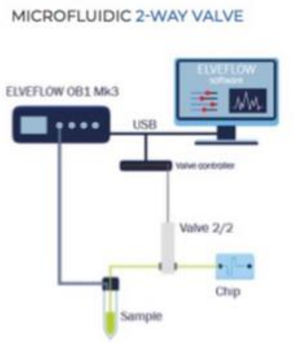


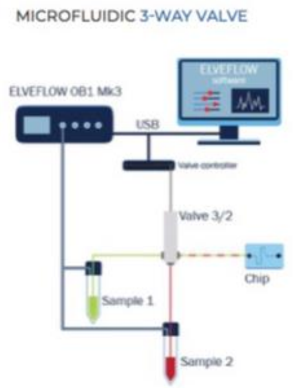
Selection valve











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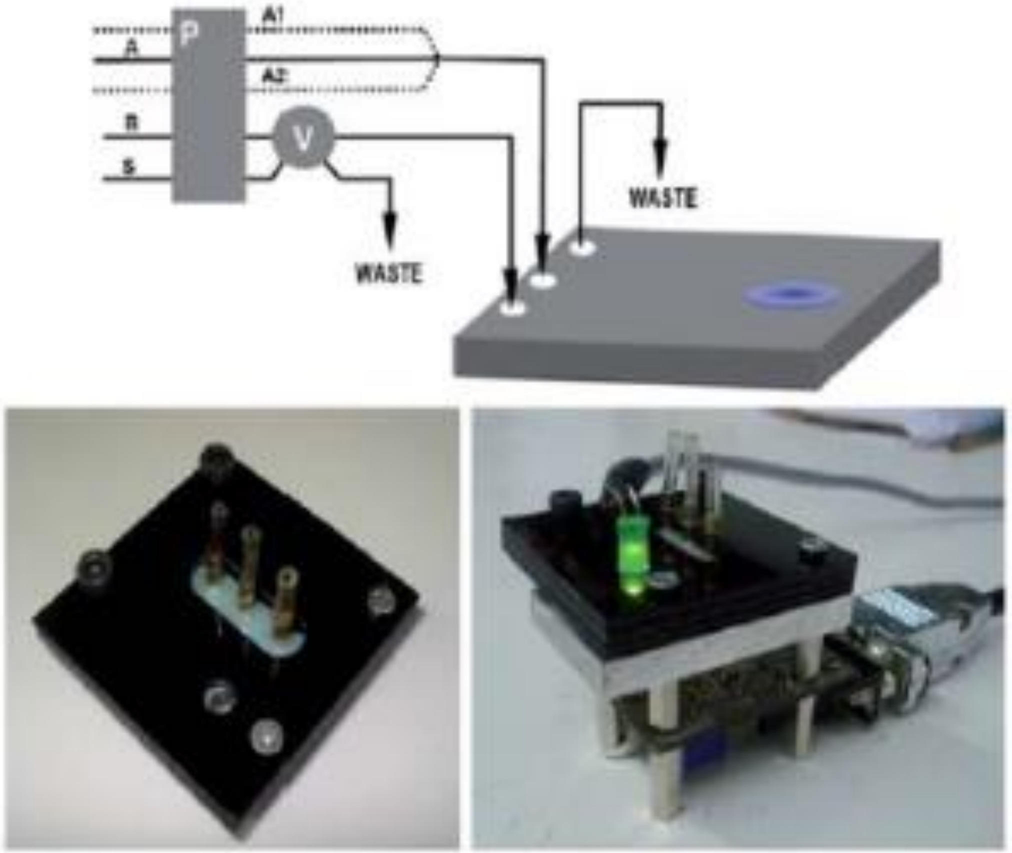
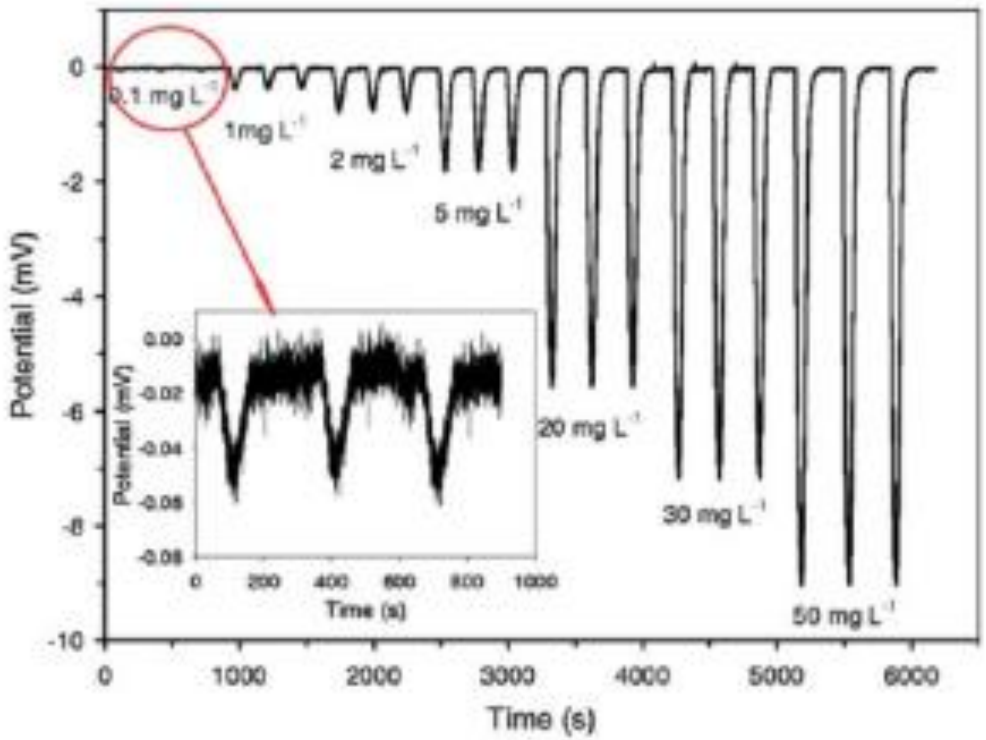
Colorimetric analysis of Cr (VI)





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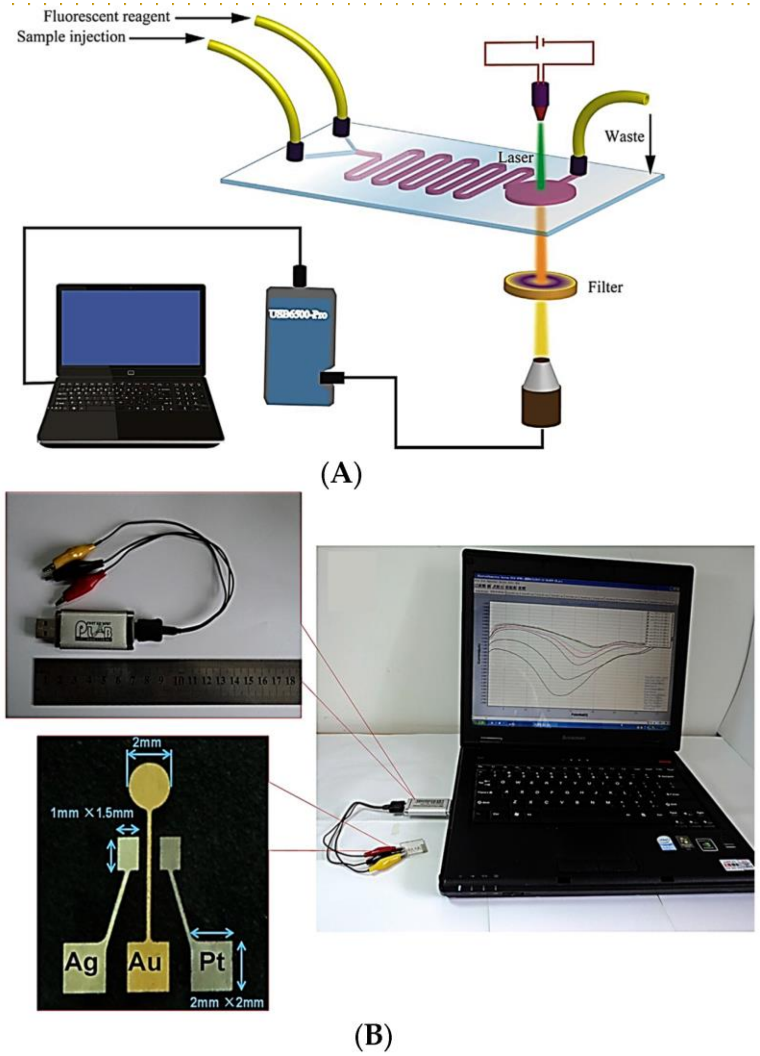
Set up for the fluorescence detection of Cr (III)



- (**A**) Set up for the fluorescence detection of Cr (III) utilizing a PDMS microfluidic device.
- (**B**) (**Right**) Sensor platform for Cr (VI) detection, (**top left**) the USB potentiostat and (**bottom left**) the sensor with the three electrodes system (Au–Ag–Pt).

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Set up for on-site measurement of Cd(II)

(B)

- (A) (a) Set up for on-site measurement of Cd(II) and (b) the disposable polymer lab chip.
- (B) Portable set up for Cd (II) detection in ground water using a microfluidic platform with a piezoresistive sensor.

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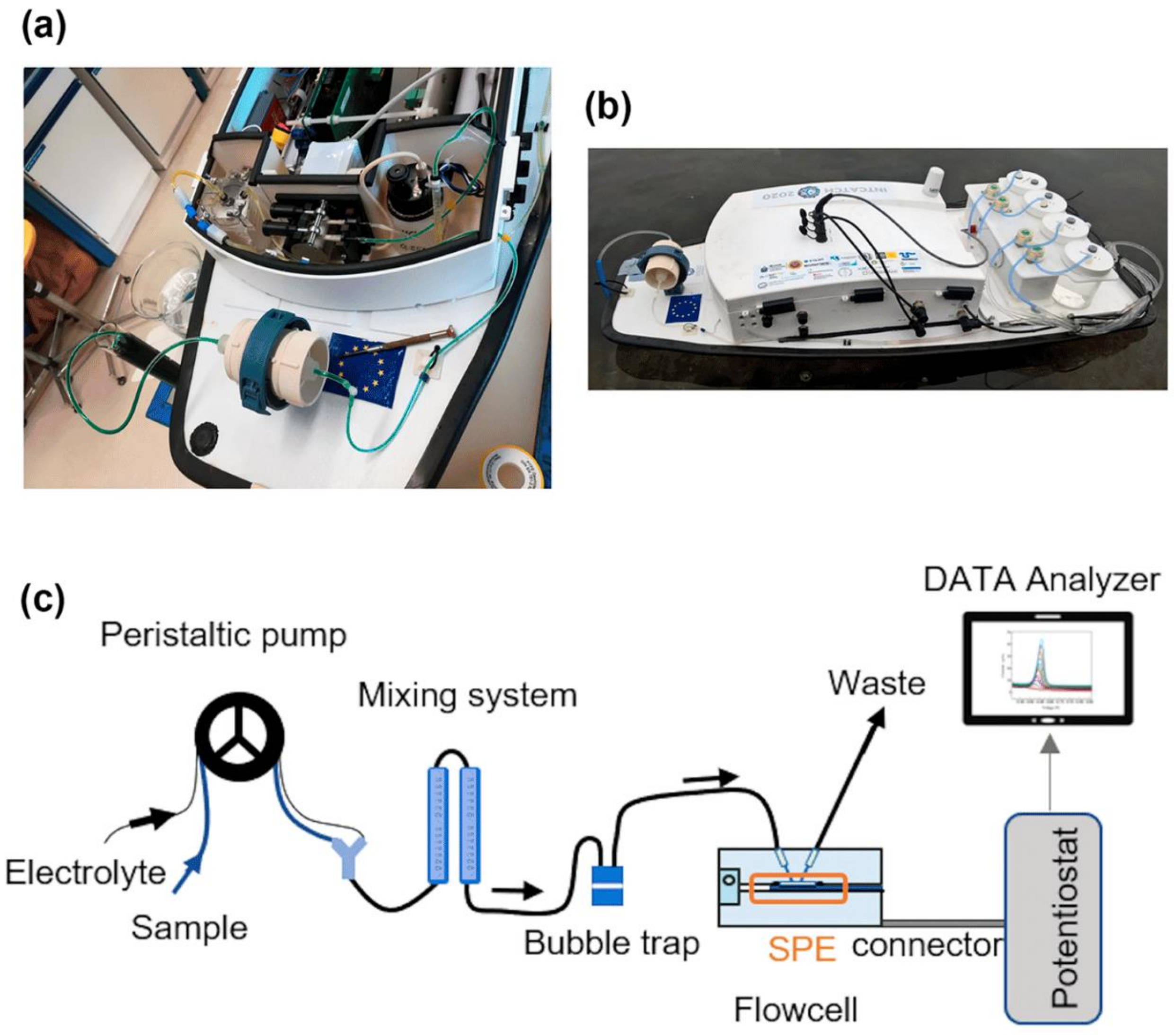
Robotic boat for Pb and Cd ions detection

University of Natural Resources and Life Sciences, Vienna

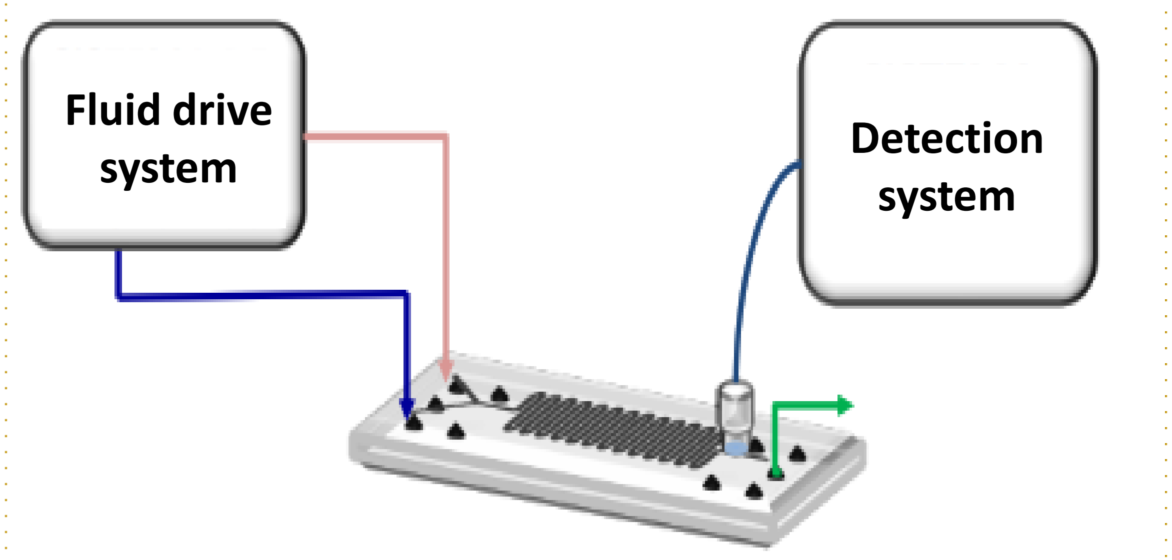


- (**a**,**b**) Images of an autonomous vehicle for Pb^{2+} detection in surface water
- (**c**) Diagram of the main parts of the microfluidic device integrated in the boat.

We got interference issues ☹

Environ. Monit. Assess. ***2022****, 194, 122.* [Google Scholar] [CrossRef]

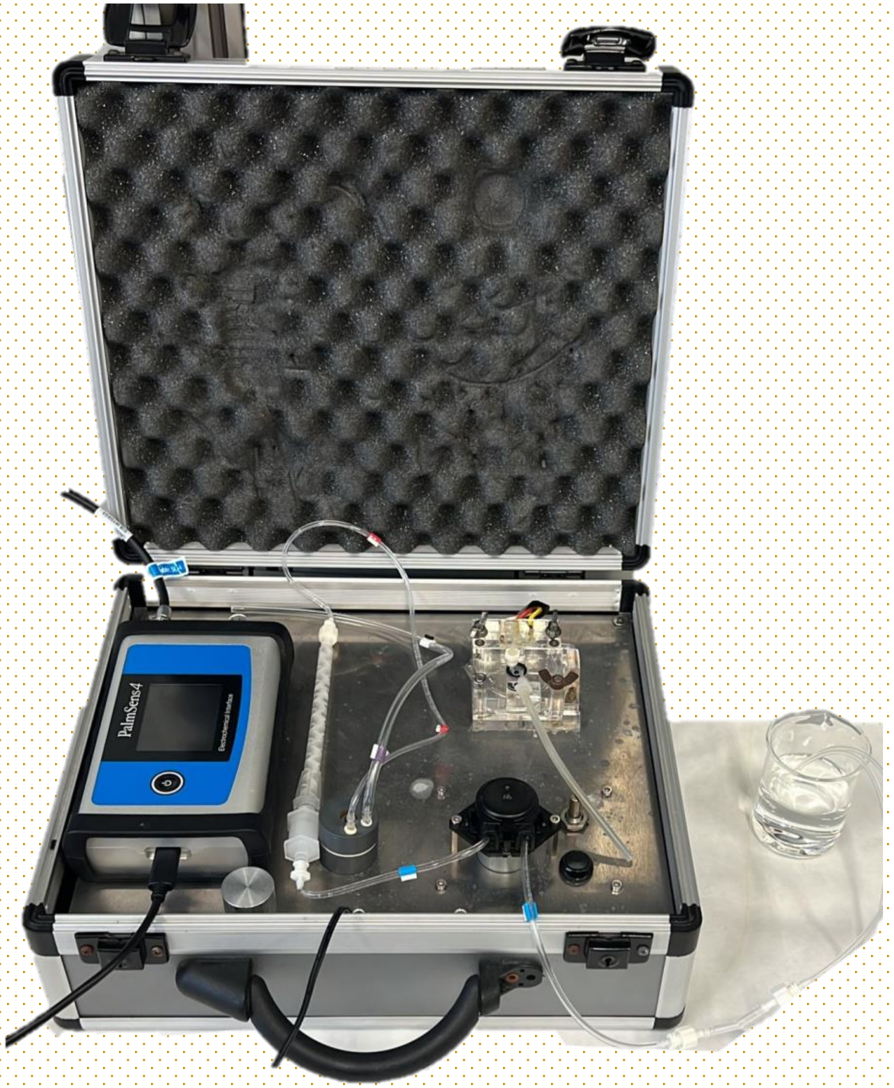
Our fluidic set up!



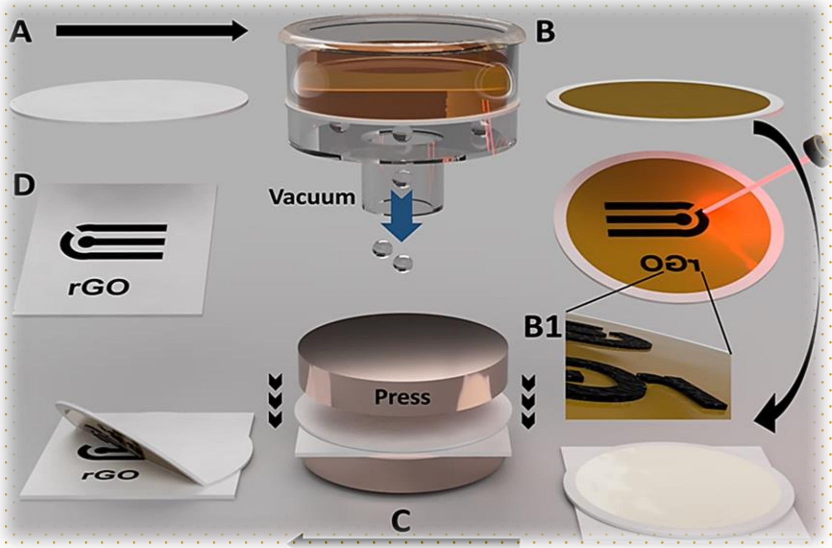
peristaltic pump

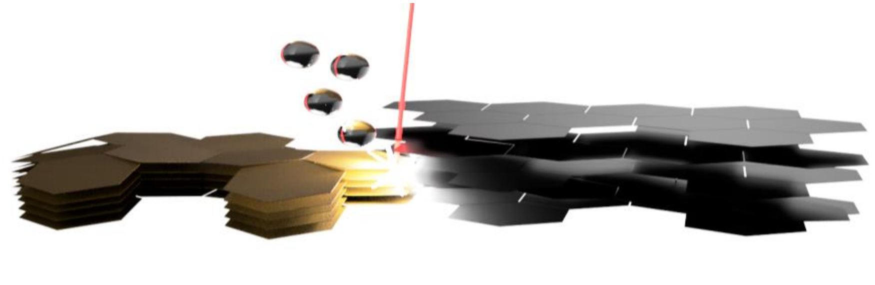
mixer and degasser

electrochemical cell

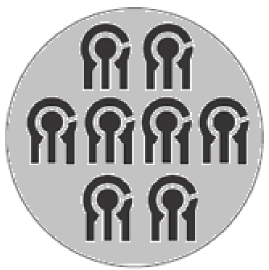


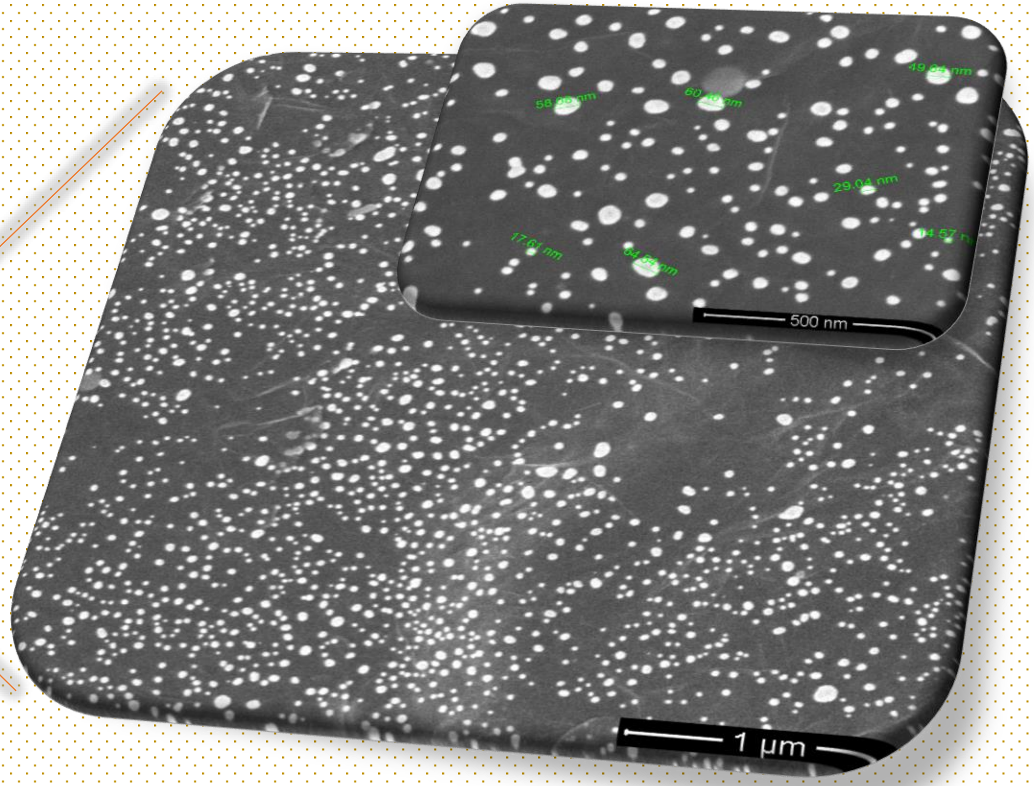
rGO-based sensors inside the electrochemical cell



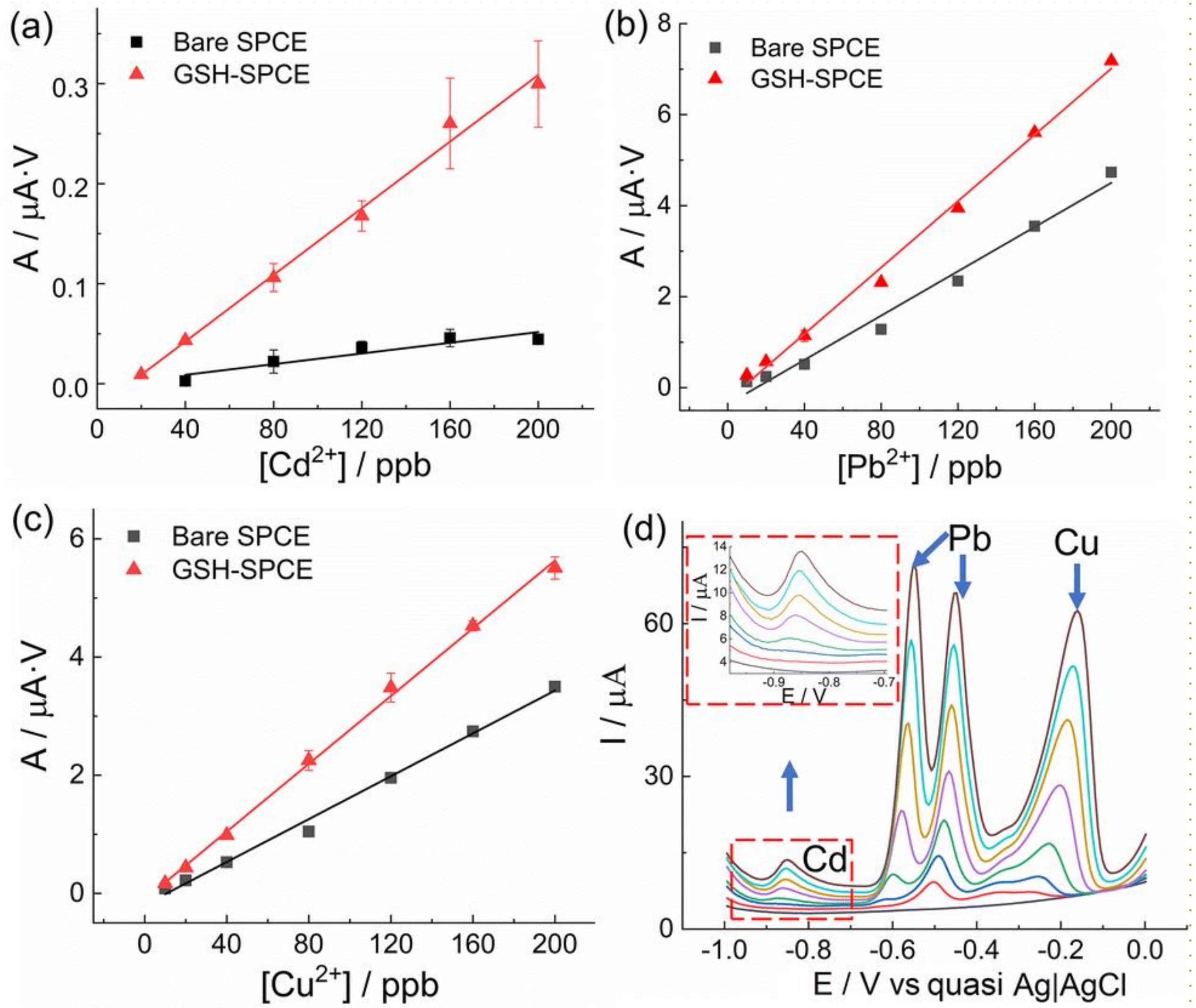


GO (non conductive) rGO (conductive)



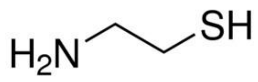


Simultaneous detection of Cd(II), Pb(II), and Cu(II) by SPCE



- ❑ Concentrations range of Cd(II), Pb(II), and Cu(II) from 0 to 200 ppb in a fixed ratio of 1:1:1.
- ❑ Calibration curves of the GSH-SPCE and bare SPCE to (a) Cd(II), (b) Pb(II), and (c) Cu(II).
- ❑ (d) Corresponding voltammograms of GSH-SPCE detecting for a blank sample to 200 ppb mixed solutions.

GSH: cysteamine covalently functionalized graphene



(Paper) Green Chem., 2023, 25, 1647-1657 10.1039/D2GC02978B

Conclusions

- Fluidic systems can help detect heavy metals.
- Electrodes made of reduced graphene oxide (rGO) enhanced with metal nanoparticles could be effective transducers for detecting Pb(II) and other heavy metals.
- Integrating these platforms and materials is really important for advancing automated technologies and better preparing for future challenges, especially in pollutant sensing.

Acknowledgments

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