Development of an experimental demonstrator for monitoring the presence of (bio)toxins in regional aquifer ecosystems

INCDTIM

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1 WHY?

Surface-enhanced Raman scattering (SERS)-based biosensors have gained prominence for detecting trace-level compounds by offering high sensitivity, multiplex capability, and non-destructive molecular fingerprinting. These advantages stems from plasmonic "*hot spots*" generated when light excites noble metal-based nanostructures, which amplify the Raman signal by factors up to 10^{-8} 10^{-11}. Recently, environmental studies were considered for the local water sources, and monitoring their content of biotoxins by using SERS. Several harmful algal blooming events occur when colonies of algae simple plants that live in regional fresh water grow out of control and produce specific toxic biocompounds.The effects of these biotoxins on the human body are under debate and could become a future reason of concern. Also, the current legislation introduces biotoxins as a class of water pollution agents. Significant input can be offered by SERS, when solid substrates with exceptional performance in real samples monitoring are developed specifically for these biotoxins.

HIGHLIGHTS:

- The device will provide the real-time detection of BIOTOXINS using SERS spectroscopy.
- In an original fashion, by using an nanopatterned solid substrate under the action of laser inside the miniaturized device, the metallic substrate is exploited for recording SERS spectra.
- The device will ultimately enable monitoring of biotoxins, reducing the time of sample preparation and of analysis. (**PN-IV-P7-7.1-PED-2024-0052**).

2 HOW?

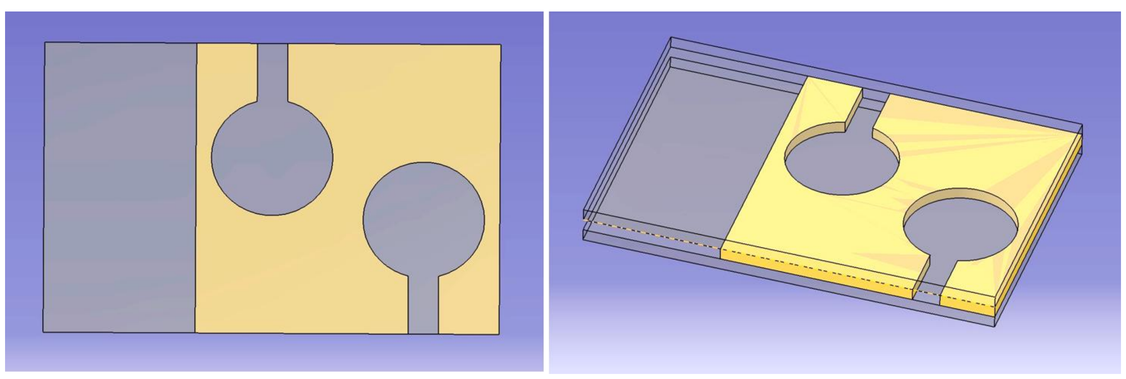


Figure 1. Device prototype (*in house design*).

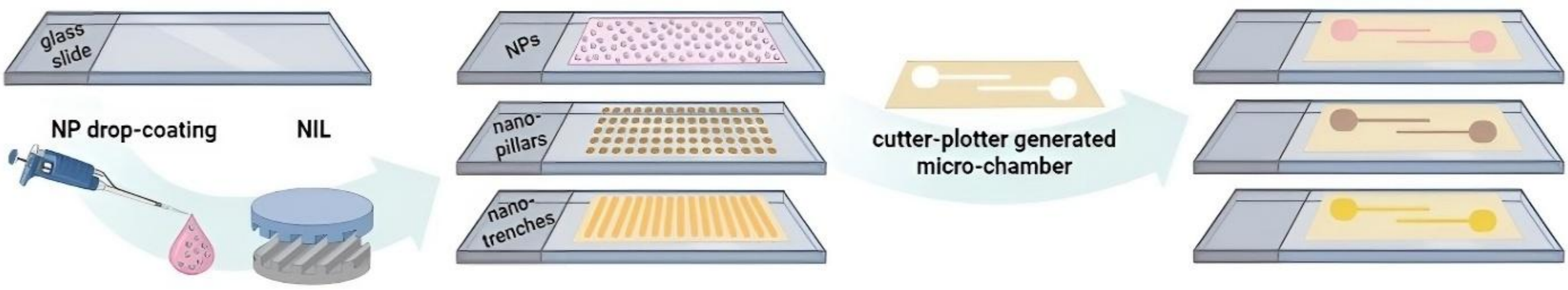
This project proposes a proof-of-principle demonstration for highly sensitive detection of (bio)toxins with minimal sample preparation: ***'mix and detect'*** for *routine on-site measurements*.

The surface-enhanced Raman scattering (SERS) detection platform is highly suitable for point-of-need sensing in different water bodies: lakes, brackish water or groundwater during strong algal blooms that can lead to (bio)toxin secretion. The water samples will be monitored using a laser line selected for resonance with the cyano-bio-elements.

3 FOR WHOM?

The **DemROTox project** offers an innovative and efficient solution in the field, namely the development of an experimental demonstrator able to monitor by SERS spectroscopy the presence of (bio) toxins in natural water samples collected from regional aquifers. Starting from a SERS-based proof-of-principle proven for organic pollutants in previous environmental applications, we will design and test a miniaturized device with high sensitivity for cyanotoxins. The CO and Partner both demonstrate previous experience in implementing real-life analyses, based either on spectroscopic or biochemical profiling of water samples. The joint expertise is supporting all planned activities, starting from ***TRL 2 towards validating the experimental demonstrator for (bio)toxins, in laboratory conditions (TRL 4) for natural groundwaters collected regionally and periodically***.

- ✓ Design and development of a simple, flexible and miniaturized device for the detection of bio(toxins) in regional aquifers, selected together with our Partner MINESA (in Transylvania - Romania).
- ✓ Detection and quantification of bio(toxins) in real water samples in our laboratory using a portable SERS spectrometer.



Schematic representation of developmental steps for the MICRO-NANO fabrication of performant SERS-substrates.

References:

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