Title:

Direct, label-free detection of Ochratoxin A using Ag capped silicon nanopillar SERS substrates

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Abstract:

Ochratoxin A (OTA), one of the mycotoxins secreted by fungi species, is classified as one of the most significant contaminants in various foods like coffee, maize, cereals and cereal products, milk, wine and beer. It is known that OTA is responsible for several diseases, hence different analytical methods including HPLC, LC-MS, immunoassays, spectroscopic methods and biosensors have been developed to quantify OTA in samples [1].

Various, nanostructure based biosensors have been evaluated to create new analytical probes for detection of OTA [2] in combination with OTA aptamers has been widely used to improve sensitivity and accuracy [3]. However, in order to simplify the detection procedure and to avoid the need for complex surface modification procedures, there is still the need to develop simple and fast methods for direct detection of OTA.

Surface-enhanced Raman Spectroscopy (SERS) is a powerful technique, capable of direct detection of molecular fingerprints of analytes, with high sensitivity and fast response time [4], therefore it would be a suitable approach for the detection of OTA. Based on our knowledge, the SERS sensors for OTA used today, are mostly based on modifying the surfaces with recognition elements such as antibodies or aptamers in order to increase sensitivity.

In this work, we present the development of a SERS sensor for direct, label-free detection of OTA using silver capped silicon nanopillars, as a low cost, fast and easy-to-use approach (Fig.1). To evaluate the dynamic range of the sensor, OTA was measured in ethanol (EtOH). The calibration curve of OTA in EtOH showed that OTA can be detected in a linear range between 0.02 to 1ppm OTA (Fig.2).

The here presented results shows a promising path for quick and portable detection of OTA in remote rural areas. In addition, the sensor sensitivity can be further improved by using the electrochemical-SERS concept.

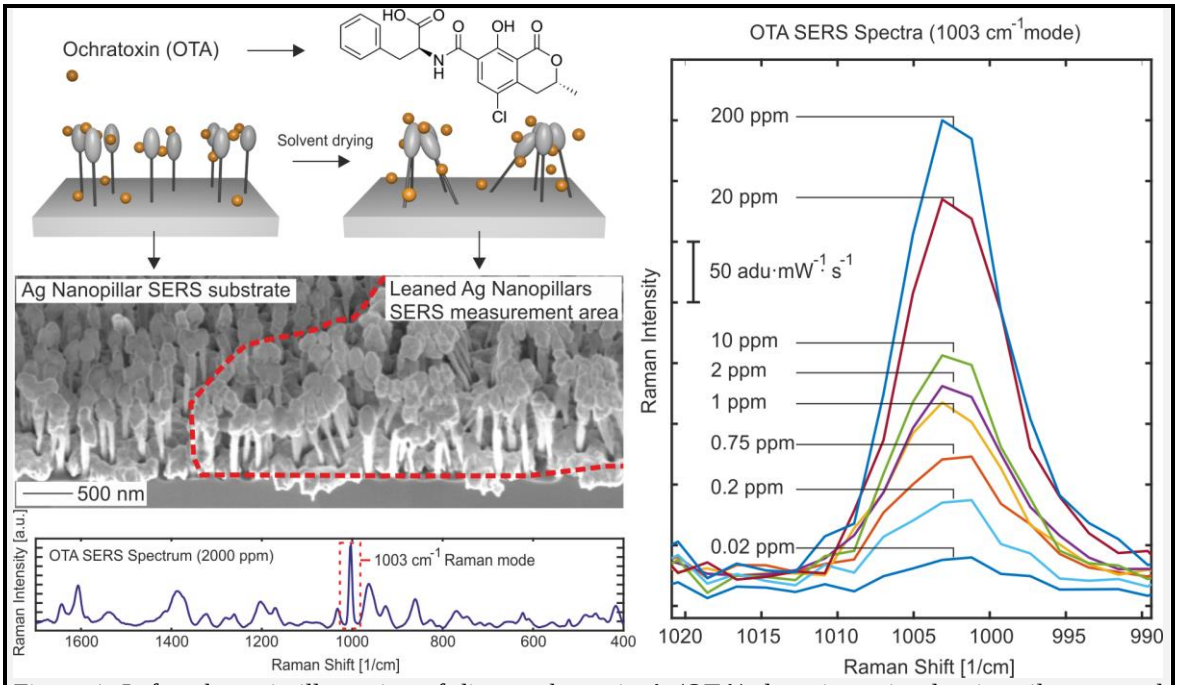

Figure 1. Left: schematic illustration of direct ochratoxin A (OTA) detection using leaning silver-capped silicon nanopillar SERS substrates. A droplet of analyte is deposited on the SERS substrate and left for drying. As a solvent evaporates, capillary forces pull the Ag nanopillars together forming microsized clusters that trap OTA in the vicinity of the so-called electromagnetic "hot spots" [5]. Right: OTA SERS spectra for concentrations varying between 0.02 – 200 ppm (1003 cm^{-1} mode).

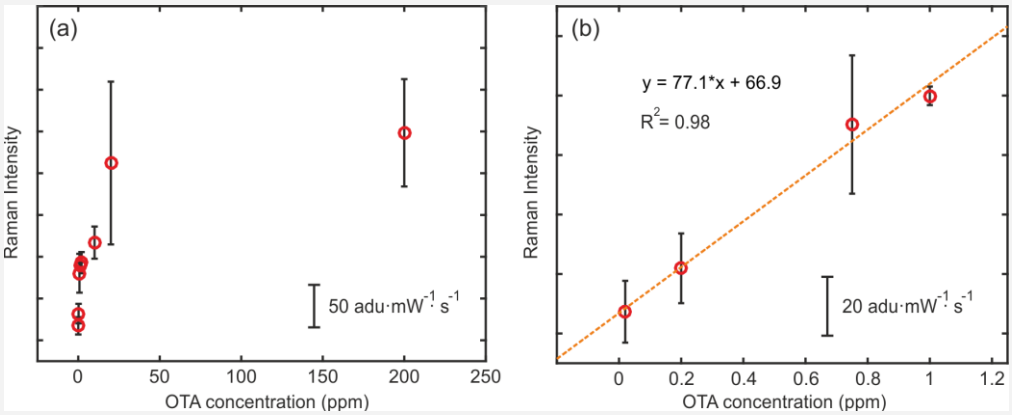

Figure 2. A) Plot of Raman intensity as a function of OTA concentration. The error bar represents the standard deviation of triplicate measurement; B) Calibration curve of OTA in concentration range between 0.02 to 1 ppm; error bar represents the standard deviations of three independent measurements.

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