

GOLD NANOSTRUCTURED SURFACE FOR THE DETECTION OF CONTAMINANTS IN WATER

M. Giardino¹, D. Pugliese¹, D. Janner^{1,2*}

¹ Dipartimento di Scienza Applicata e Tecnologia, Politecnico di Torino, Torino, 10129, Italy

² National Interuniversity Consortium of Materials Science and Technology (INSTM),
Florence, Italy

[*davide.janner@polito.it](mailto:davide.janner@polito.it)

We will report on the realization of cost-effective SERS probes for portable systems for the detection of contaminants in water reaching sensitivities below 300 part-per-trillion.

Keywords: List of a maximum of two keywords

1. Introduction

The presence of biological contaminants like pesticides constitutes and hormones present a serious threat to health and safety of human beings and their surrounding environment influencing the agricultural and food processing industry. In particular, there is a lack of quick analytical tools with enough sensitivity to issue an early warning of contamination in the environment or screening in the agri-food processing. Surface enhanced Raman scattering (SERS) is a technique that can be made sensitive and quick to comply with these requirements [1]. While many demonstrations of ultra-high sensitivity detection in SERS have been reported [1,2], mostly these performance leverages on a complicate fabrication via e-beam lithography or on the use of special particles in colloidal form. In this work, we will present our recent advances in the development of low-cost nanostructured gold surfaces for the detection of contaminants and hormones [3] suitable to be used in portable analytical tools. We will show that their sensitivity and accuracy are well beyond the needed detection limits and through a careful engineering of the surface properties we achieve a great uniformity of the distribution of the hotspots reaching a variability of the SERS signal over 100 μ m x 100 μ m surface of less than +/-2%.

2. Materials and methods

To obtain the optimized gold Grown Nanostructured Surface (GNS), we investigated the different steps involved in the fabrication and evaluated the impact of them on the SERS signal for a test monolayer of MBA. The steps to obtain GNS substrates can be divided as follows: functionalization of the substrate, gold seed deposition, and growth. A glass substrate with roughness < 0.2nm was used to deposit the seed nanoparticles. The substrate was functionalized with Amino-propyltrimethoxysilane (APTMS) and then Au nanoparticles have been deposition in a controlled way to form an optimized particle monolayer with controlled average distance between the nanoparticles. After particle deposition, the nanostructured surface has been grown via a reduction reaction ($\text{HAuCl}_4 + \text{H}_2\text{O}_2$) in a controlled way so to obtain the final GNS. Contaminants were deposited on the sample in drops and after 20 minutes Raman measurement at 785nm was taken.

3. Experimental results

Raman measurements were taken for different water contaminants such as Carbaryl, Thiram, and Nitrates. The calibration curve for the detection of Thiram is reported in figure 1 showing a limit of detection (LOD) of 1.13nM corresponding to 270 part-per-trillion. Given the scalable and cost-effective fabrication process- we estimate a cost of about 3/5 EUR per analysis-and the possibility of using easily these probes in portable Raman systems, the results are promising in particular for the field of early detection of contamination and drinking water quality control.

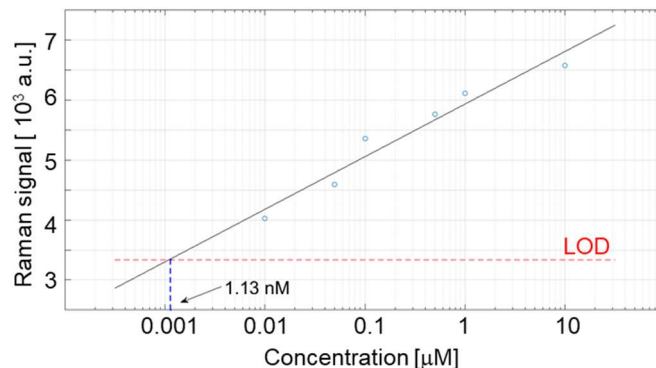


Fig. 1 Calibration curve for Thiram showing LOD=1.13nM (270ppt).

Acknowledgements

D.J. acknowledges support from the NATO SPS program (project G-5250) and to Compagnia di San Paolo through the Starting Grant project.

References

1. Lane, L. A.; Qian, X.; Nie, S. *Chemical Reviews*, 2015, 115, 10489.
2. J. F. Betz, W. W. Yu, Y. Cheng, I. M. White, G. W. Rubloff, *Physical Chemistry Chemical Physics*, 2014, 16, 2224
3. World Health Organization - <https://www.who.int/>