SILVER NANOWIRES ARRAYS AS SERS SUBSTRATE FOR BIOMOLECULES DETECTION

Chiara Amicucci, Martina Banchelli, Cristiano D'Andrea, Daniele Ciofini, Marella de Angelis, Salvatore Siano, Roberto Pini, Paolo Matteini*

Istituto di Fisica Applicata Nello Carrara, Via Madonna del Piano 10, 50019 Sesto Fiorentino, Italy
**p.matteini@ifac.cnr.it*

Plasmonic substrates for SERS analysis require abiding by a number of characteristics in order to find application in basic research and sensing. Here we present a SERS-active substrate composed of assembled silver nanowires that satisfy most of the requirements and that can be used for effective detection of biomolecules.
Keywords: SERS, silver nanowires

1. Introduction

Plasmonic substrates for surface-enhanced Raman scattering (SERS) analyses in basic research or real life applications require abiding by a number of characteristics such as enough sensitivity, high reproducibility, low production costs, fabrication methods suitable for high volume manufacturing, reduced training times and skills needed for their routine usage, integration potential with portable Raman systems for on site applications, simple reusage or disposable characteristics and quick processing of a variety of samples. The above considerations hold particular significance when life science and healthcare applications of SERS are concerned, whose primary conditions are high-throughput multisample and inexpensive analyses at reduced costs. In the last decade great efforts have been exerted in the development of functional SERS substrates obtained by simple, low cost, rapid and scalable fabrication methods, such as micropipetting, screen- and inkjet printing, and filtration of colloid solutions of plasmonic nanoparticles. In this work we demonstrate the possibility to take advantage of rapid and inexpensive fabrication techniques to produce disposable SERS substrates [1] that can be integrated with a simple spot-on analysis specifically adapted for reliable detection and characterization of molecules of biomedical interest.

2. Results and Discussion

Silver nanowires with high aspect ratio were assembled by different deposition techniques on hydrophobic substrates. This bottom up assembly was followed by spot arrays design and fabrication through laser patterning of the silver nanostructured surface, leading to the formation of circular spots of defined size aimed at both concentrating microliter volumes of aqueous solution droplets and enhancing the Raman signal of micromolar amounts of biomolecules.

The spot arrays so produced were efficiently tested as SERS sensors via direct detection, i.e. by direct measurement of the analyte molecular Raman fingerprint, of several proteins of interest in GMOs identification as well as of biomarkers of neurodegenerative diseases. The substrates showed excellent reproducibility and sensitivity. The specificity of the detection system is intrinsic in the Raman spectroscopic signal, which enables a structural characterization of the biomolecules while a rapid and effective detection is performed. The silver spot arrays can also represent a versatile label free SERS platform for indirect biomolecular detection, thanks to the simple and easy functionalization of the silver spots by thiolated small molecules and receptors.

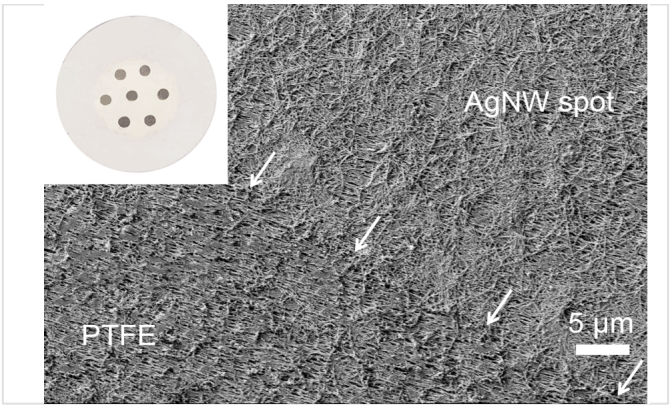

Fig. 1 SEM image of a laser patterned silver nanowire@PTFE substrate at the edge of a silver spot (indicated by the arrows). Inset: image of a laser-patterned produced substrate.

Acknowledgements

Authors acknowledge the European Community within the EuroNanoMed3 ERANET cofund (H2020) project SPEEDY (ID 221) and Tuscany Region in the framework of the POR-FESR 2014–2020 program Action 1.1.5.a3 project SENSOGM.

References

1. Banchelli, M., Amicucci, C., Ruggiero, E., D'Andrea, C., Cottat, M., Ciofini, D., Osticioli, I., Ghini, G., Siano, S., Pini, R., de Angelis, M., Matteini, P. *ChemNanoMat* **5**, 1036-1043 (2019)