Surface Enhanced Raman Spectroscopy substrates based on silver nanoparticles and thin films

L. Patsiouras*, M. Panagopoulou, S. Stathopoulos, Y. S. Raptis, D. Tsoukalas
School of Appl. Math. & Phys. Sciences, NTUA, GR157- 80, Athens, Greece

The exploration of new techniques for precise, reproducible and rapid detection of chemical substances has concerned the scientific community the last years. Surface Enhanced Raman Spectroscopy (SERS) is a novel, well established method of chemical sensing [1]. This technique is based on an effect in which metallic nanostructured surfaces enhance the scattered Raman signal by molecules which are attached to these surfaces [2]. The plasma resonance of the free electrons of the metal surface is responsible for the enhancement of the local EM field scattered by the molecules which are close to the surface.
In this work we compare the SERS signal obtained from various substrates that we particularly prepare to optimize amplification using a prototype molecule for detection such as Rhodamine. Our first approach makes use of periodic structures decorated with silver nanoparticles. Nanoparticles of average diameter 5 nm observed by Transmission Electron Microscopy** were fabricated by a physical deposition method based on DC sputtering and gas condensation. Thus periodic structures were fabricated on silicon through the fracture induced structuring technique (FIS) [3] and electron beam lithography and they were coated with silver nanoparticles. The alignment of nanoparticles across the sharp peaks on resist and their aggregation in bigger clusters produce pure SERS signal up to 100 times stronger than the normal signal gained from a surface without nanoparticles. An another category of SERS substrates which was developed, is making use of thin silver films deposited by sputtering on a pre-strain PDMS sample [4] with thickness of 8 to 12nm. By this way the semi-continuous metal film causes the signal enhancement which strongly depends by the film thickness.
The SERS signals obtained from the above approaches will be compared and discussed.

References

[1] X., Y., Zhang, M., A., Young, O., Lynardes, R., V., Duyne, J. Am. Chem. Soc., **127**, 4484, 2005.
[2] P., Hildebrandt, M. Stockburger, J. Phys. Chem., 88 (24), 5935-5944, 1984.
[3] L., Pease, P., Deshpande, Y., Wang, W., B., Russel, S., Y., Chou, Nature Nano., 2, 545-548, 2007.
[4] P., C., Lin, S., Yang, Appl. Phys. Lett., **90,** 241903, 2007.

* lampros.p88@gmail.com

** the TEM study was carried out in the ”Centre for Electron Microscopy, Microanalysis and Structural Characterization of Materials” of the School of Mining and Metallurgical Engineering- NTUA