November 12-13 2024
RamanFest
Paris | FRANCE

István Csarnovics
Department of Experimental Physics, Institute of Physics, Faculty of Science and Technology, University of Debrecen, Bem sq 18/a, Debrecen, Hungary

csarnovics.istvan@science.unideb.hu

Peculiarities of using different nanostructures for surface-enhanced Raman scattering

Raman spectroscopy is a branch of vibrational spectroscopy that allows highly sensitive structural identification of various chemical and biological materials based on their unique vibrational characteristics, all without destroying the sample. Raman spectroscopy is an effective tool for analytical studies, but the low intensity of Raman signals is a significant disadvantage of the method.

The surface-enhanced Raman scattering (SERS) method could enhance the light-matter interaction during the Raman process, mainly through nanostructures. The enhancement of the SERS process depends on the material, shape, and geometrical parameters of the nanoparticles while simultaneously on the excitation wavelength and the nature of the selected analyte. Different nanostructures (nanoislands, nanoparticles, nanotrees) were created and analyzed, and their parameters were optimized to obtain a higher enhancement factor and to determine the detection limit of the selected analyte. Also, the different creation methods were compared from the point of view of the sensing application. SERS is a commonly used technique to enhance the signal that allows the analysis of low-concentration samples or even the detection of a single molecule. The SERS effect can occur when the analyte is near a nanoscale-structured metal surface. By using metal surfaces with optimal parameters, the intensity of Raman signals can be enhanced by several orders of magnitude.

Our previous research shows that thermal dewetting of thin metallic layers could be used for SERS application. In this research, we compare the results obtained during the examination of nanostructures created by spark ablation and vapor-liquid-solid techniques to find the optimal creation parameters for the SERS substrate with a higher enhancement factor, which is suitable to detect the least analyte and will be ideal for further applications. Figure 1 shows the Scanning electron microscope images of different nanostructures for the SERS application.

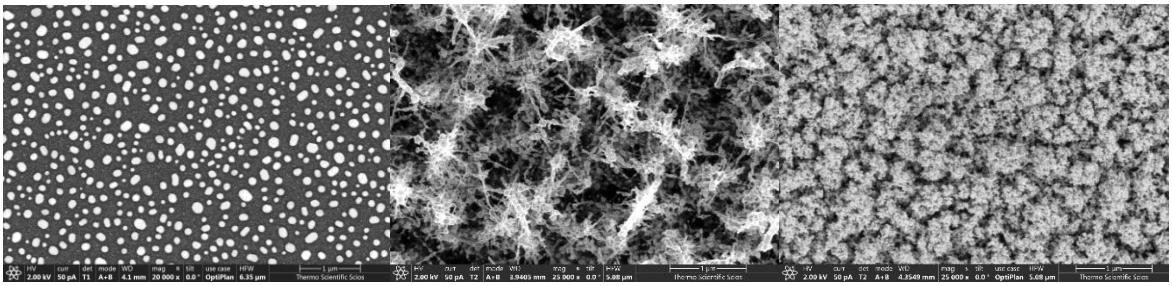

Figure 1: Scanning electron Microscope images of the created and investigated nanostructures: a) Thermal dewetted gold nanostructures, b) Carbon nanotrees covered by gold layer, c) Ag-Au gold nanostructures created by arc-discharge method.