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Ultrasensitive detection of analyte molecules at attomolar concentration by Raman spectroscopy

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Abstract

Surface-enhanced Raman scattering (SERS) is a technique developed to detect extremely small quantities of molecules by determining their characteristic Raman signal. However, the adoption of SERS remains limited due to the difficulties in fabrication of highly sensitive and reproducible nanostructured plasmonic platforms. From this point-of-view, self-assembly techniques of SERS substrates formation allowing fabrication of highly branched dendritic silver nanostructures, to our opinion, are very promising for highly sensitive biosensor applications. We also used so-called Ag corrosive deposition on a macroporous silicon (macro-PSi) template to grow 3D silver dendritic structure that demonstrated an unprecedented sensitivity in SERS spectroscopy. With the use of such substrates, it was possible for the first time to detect 4-MBA and DTNB molecules with very low concentrations of 10-16 M and 10-18 M, respectively. Besides, we examined SERS spectra of the human lactoferrin molecules adsorbed on a silvered porous silicon (P-Si) from 10-6–10-18 M solutions. To prevent overheating the analyte molecules on the silvered por-Si were protected with graphene, which allowed the detection of lactoferrin adsorbed from the 10-18 M solution.

Thus, the SERS measurement results indicate the possibility of ultra-low analyte concentration detection, comparable to the concentrations of single molecules.

Biography:

Dr. Grigory Arzumanyan (Ph.D.- in physics), head of the Department of Raman Spectroscopy (Centre "Nanobiophotonics") at the Joint Institute for Nuclear Research, Assoc. Prof. of the Dubna State University, Chairman of the regional board of Russian Nanotechnology Society (RNS) in Dubna, Russia. He received his doctoral degree in physics at the Moscow Engineering Physics Institute. The main research activities are currently focused on the Raman spectroscopy and microscopy, including nonlinear imaging using Coherent antiStokes Raman Scattering (CARS), second harmonic generation (SHG), and Surface Enhanced Raman Scattering (SERS). The other field of research interests deals with luminescence and up-conversion luminescence studies of rare earth elements in various optical matrices; and plasmonic enhancement effects of those processes on nanostructured surfaces.

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