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Upgraded Nanoparticle-Based SERS Substrates: Superhydrophobicity and Oxidative Treatment

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Upgraded nanoparticle-based SERS substrates: superhydrophobicity and oxidative treatment

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Andrei A. Novikov, Ph.D. in Chemistry, is a Senior scientist, and Assistant professor at Dept. of Physical and Colloid Chemistry, Gubkin University, Moscow, Russia.He is teaching the classes: "Physical Chemistry", "Kinetics and Catalysis", "Surface Phenomena and Disperse Systems", "Biotechnology in Oil and Gas Industry", "Advanced Physical Chemistry". Under his supervision, 2 master's theses are presented each year.His research group develops express methods of identification of microbes, including lipid analysis and SERS studies. Interests: metrology, regression analysis, and developing the scripts in GNU/Octave and Matlab for automated spectra processing.

Abstract

Introduction

Gold nanoparticles can be easily assembled to potent substrates for surface-enhanced Raman spectroscopy (SERS). We studied additional amplification of SERS signal by the oxidative treatment [1], and by providing the superhydrophobic properties of the substrates.

Methods

We have synthesized nearly spherical citrate-capped gold nanoparticles of different size from 20 to 120 nm by known method with modifications [2]. The maximum enhancement (above 10^6) in SERS experiments with 785-nm excitation (BWTEK BWS415) was provided by structures fabricated from 50-nm nanoparticles. Superhydrophobic substrates were produced by drop-casting of C18-silanized halloysite nanotubes dispersion.

Results

These nanoparticles demonstrated catalytic activity in oxidation of dyes with hydrogen peroxide, following the pseudo-first-order kinetics. In SERS-controlled catalytic experiments we observed additional enhancement, and the maximal one was observed with 3%(v/v) hydrogen peroxide. Exploiting this phenomenon, we detected model analytes at concentration of 5×10^{-9} M, while it was impossible without the hydrogen peroxide addition. Further improvement in the SERS substrates sensitivity was achieved by aggregation of gold nanoparticles on the superhydrophobic surface.

Discussion

The nanoparticle-based SERS substrates can be upgraded by making the hot spots available for adsorption of analyte, and by concentrating the analyte on the superhydrophobic surface. The substrates upgraded this way have the sensitivity more than an order higher in comparison with simple drop-casted substrates.

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2. N.G. Bastus, J. Comenge, V. Puntes. *Langmuir*, 2011, 27, 11098.

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