SERS spectroscopy for the detection and identification of microorganisms

Monday, 25th September - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 460

Dr. Dmitry Kopitsyn [1], ***Mr. Maksim Gorbachevskii*** [1], ***Dr. Ekaterina Botchkova*** [1], ***Dr. Pavel Gushchin*** [1], ***Prof. Vladimir Vinokurov*** [1], ***Dr. Andrei Novikov*** [1]

1. Gubkin University

Introduction

Detection of microorganisms is an important task in the fields of clinical diagnostics, food safety, and water quality control. The severity of this problem is due to the emergence of clinical infections by multidrug-resistant biofilm-forming bacteria. Traditional methods based on cultivation or PCR are effective, but usually require some preliminary information about the nature of pathogens, take a lot of time and are quite costly, which in most cases makes such studies not applicable. Thus, the problem of a broad-spectrum, feasible and fast way of detecting and identifying microorganisms remains relevant today.

Surface enhanced Raman scattering (SERS) spectroscopy can be efficiently employed for the label-free detection and discrimination of different bacteria. The fingerprint-quality bacterial spectra allow identification of bacteria at the genus, the species, and even at the intraspecies level.

Methods

SERS spectra were acquired with BWS415 spectrometer (BWTEC, Germany). The specimen was put on the XYZ-stage, while the position of laser focus was controlled by USB microscope Mikmed-2000R (Micromed, Russia). For maximum enhancement, SERS substrates were prepared by multilayer deposition of gold nanoparticles without any additional coagulants.

Results

SERS spectra were obtained for the active Gram(+) and Gram(-) bacteria cells and for spores, such as *Escherichia coli*, *Staphylococcus aureus*, *Micrococcus luteus*, *Bacillus mycoides*, *Bacillus thuringiensis*var.*cereus*, *Desulfovibrio sp*. Spectra of bacteria grown on ^{15}N isotope containing substrate were also registered. Fluorescence background subtraction, filtering, normalizing and automated peak recognition were performed by means of GNU/Octave subroutines developed by us for the processing of spectral data.

Discussion

SERS spectra of bacteria were collected with cheap portable Raman spectrometer. All spectra have distinct differences, including those between spectra of cells and spores of the same strain. Stable isotope labeling revealed the relation between major SERS peaks and N-X bonds oscillations (presumably, in adenine and guanine cycles) – these peaks shifted towards lower Raman shifts. The PCA dimensionality reduction revealed the correlation between certain peaks in bacterial spectra and provided an opportunity to study the changes in cell surface chemistry in the biofilms formation by clinically relevant bacterial species.

This work was funded by the Russian Science Foundation (project 17-79-10489).