Investigation of bilayer lipid membranes on nanostructured Au and Ag substrates by surface enhanced Raman spectroscopy

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Abstract

Membranes are essential components of any living cell and therefore, bilayer lipid membranes (BLMs) are simplified planar models of cell membranes, commonly employed for both fundamental and applied studies [1-2]. Raman spectroscopy is a well-established, analytical tool that has been widely applied to biological and medical research. However, the sensitivity and spatial resolution of Raman spectroscopy at the nanoscale is very weak [3] and it is inappropriate method for studying single lipid bilayers.

The aim of our study was evaluate the suitability of surface enhanced Raman spectroscopy (SERS) to the investigations of BLMs. While single-bilayer sensitivity could be achieved by SERS, adsorption on a roughened metal surface, what is specific for SERS, may be unsuitable for phospholipids. In our study BLMs were formed on optically active surfaces based on Ag or Au nanostructured film deposited by chemical reduction using HF etched silicon.

To illustrate the use of this technique, we present a study of bilayer lipid membranes formed of one part of negatively charged phospholipids (DOPS) and four parts of neutral phospholipids (DOPC) and compare the behavior of the BLMs on different SERS substrates. The Raman spectra of BLMs on silicon surface are presented for comparison (fig.1).

It was found that Au SERS substrates were not suitable for lipid membrane formation, but after using the binding 1-dodecanothiol layer the appropriate results were obtained. In conclusion we demonstrate that SERS can be efficiently used for investigation of a thin layer of lipids.

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References

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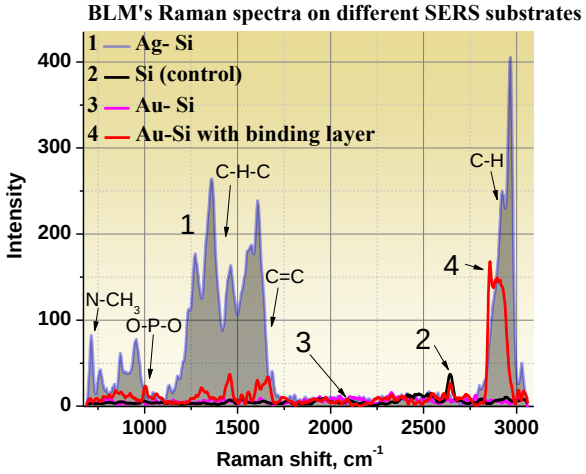

Figure 1. Raman spectra of bilayer lipid membranes on different SERS substrates in PBS solution