The Au-coated AISI 304L stainless steel plates as effective NALDI substrates for the detection of low molecular weight compounds

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INTRODUCTION

The nanostructure-assisted laser desorption/ionization (NALDI) method is a modern approach enabling the analysis of low molecular weight compounds (m/z < 3000 Da)[1,2,3]. Compared to the MALDI technique, NALDI eliminates the problem of background interference from the organic matrix, which significantly improves the quality of the obtained mass spectra[1]. The developed invention focuses on the method of manufacturing steel plates coated with gold nanolayers, which are intended to support the desorption and ionization processes in mass spectrometry, which makes them exceptionally effective in NALDI applications. NALDI, as an analytical technique, involves the use of surfaces covered with nanostructures (in this case gold nanolayers) to desorption and ionize the sample without the need for a matrix. This technology allows for obtaining more precise mass spectra, especially for low molecular weight compounds. For that reason, NALDI is gaining popularity in medical diagnostics and the analysis of biologically active compounds.

EXPERIMENTAL/THEORETICAL STUDY

The Au nanolayers (2-20 nm) were deposited on the stainless steel (AISI 304L) using the PVD method. The morphological features of the fabricated samples were investigated by means of atomic force microscopy (Innova, Bruker) and scanning electron microscopy (Quanta 3D, FEG). Thicknesses and optical constants of the gold films have been determined using the spectroscopic ellipsometry (V-VASE, J.A.Woollam Co., Inc.) technique. The Au-coated coated AISI 304L plates were used as a NALDI substrates to detect serine (m/z ~105 Da) and methionine (m/z~149 Da), lactose (m/z ~365 Da), arabinose (m/z~150 Da), ampicillin (m/z ~349 Da) and cefotaxime (m/z ~455 Da). The mass spectra were recorded using the UltrafleXtreme II MALDI-TOF-MS device (Bruker).

RESULTS AND DISCUSSION

The formed Au films are non-continuous (2 nm), at the percolation threshold (5nm) or continuous (10 and 20 nm) and were used as substrates for analyte in the NALDI-MS technique. In studies on amino acids such as serine and methionine, the NALDI-MS technique showed exceptional sensitivity, allowing detection of compounds in a wide concentration range from 0.1 µg/mL to 10 µg/mL. Lactose and arabinose were detected in a wide range of concentrations from 0.5 µg/mL to 20 µg/mL, which confirms the potential of this method in the analysis of biologically important carbohydrates. The results of the analysis of antibiotics such as ampicillin and cefotaxime confirmed the effectiveness of the NALDI-MS technique in detecting in the concentration range from 0.2 µg/mL to 15 µg/mL showed that gold nanolayer coated plates significantly improve the sensitivity and accuracy of antibiotic detection.

CONCLUSION

The NALDI-MS analysis performed using the Au-coated AISI 304L stainless steel plates allowed obtaining the mass spectra of exceptional quality for serine, methionine, lactose, arabinose, ampicillin and cefotaxime. The recorded spectra are characterized by low noise, high resolution and significant detection sensitivity, which allows detection and analysis of a wide range of chemical compounds, even at very low concentrations.

REFERENCES

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