ORI101

Plasmonic nanoparticle-built surfaces: The effective tool for (bio)molecules detection

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Matrix-assisted laser desorption ionization mass spectrometry (MALDI-MS), the technique connected with Nobel Prize, has become an important analytical tool capable to detect various molecules including peptides or whole proteins. However, conventional MALDI-MS using organic matrix has two intrinsic limitations: (i) it provides mostly qualitative results and (ii) organic matrix spectra often interfere with low-mass biomolecules. Therefore, a lot of measurements are usually needed to find so-called “sweet spots” from which mass spectra with sufficient quality are obtained. The presence of “sweet spots” is pointing to the sample inhomogeneity, here caused by matrix distribution in a sample. This brought us to two fundamental questions: Is it possible to make all spots “sweet”? Is it possible to detect small molecules without matrix interference? Both questions may be answered yes if the organic matrix is substituted by inorganic plasmonic nanoparticles (NPs) as will be presented. First, the drops containing low-mass analyte are dried into concentrated spots on conductive plates with tailor-made wetting properties. Then the dried analyte is homogeneously overcoated by the silver NPs synthesized in a gas aggregation source, which as low-pressure plasma based technique ensures high purity of produced NPs and allows tailoring their size, morphology, etc. This, in turn, enables to match NPs plasmonic absorption with the wavelength of the used Nd:YAG laser (355 nm). We prove that the biomolecule peaks intensity is strongly linked with the amount of deposited Ag NPs showing maxima for the highest surface density $3x10^3$ NPs/μm^2 at which the NPs still do not form an interconnected metallic network. The biomolecules signal intensity is then comparable to MALDI-MS organic matrix measurements acquired at the “sweet spots” with the detection limit of $3x10^{-8}$ g/L and excellent spectra reproducibility (SD 10 %) and therefore presented technique is applicable for advanced mass imaging. (Support by TACR Gama TP01010019 is acknowledged)

Keywords
nanoparticles