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Systematic control of ion desorption efficiency and heat transfer in surface-assisted laser desorption/ionization

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The detection sensitivity of Surface-Assisted Laser Desorption/ionization Mass Spectrometry (SALDI-MS) has been found to be affected by the extent of energy transfer from SALDI substrate to analyte molecules. Although it was well reported that such energy transfer controls the detection sensitivity of SALDI-MS by affecting the efficiency of desorption/ionization processes, there are still lack of substrates that allows systematic control of the processes. Here, the laser desorption mechanism(s) of gold nanoparticles (AuNPs, Ø: 2.5 nm) was being investigated via the combination of mass spectrometric experiments (by survival yield method) and molecular dynamics simulation. By correlating the experimental and computational results, it was revealed that laser-induced heating and phase transition of the nanoparticles (including melting, vaporization and phase explosion) could have diverse effects on the ion desorption efficiency and the heat transfer. The ion desorption efficiency increased rapidly with laser fluence as the substrate underwent phase explosion. The enhancement effect on the ion desorption efficiency became less significant as the substrate underwent vaporization, while the effect of substrate melting was not noticeable. Besides, it was noticed that the phase explosion has a significant effect in cooling down the desorbed ions and reducing the extent of ion fragmentation. Based on this understanding on the laser desorption mechanism(s), Ag-Au alloy NPs was developed as a tunable substrate for SALDI-MS. By changing the metal composition of the alloy nanoparticles, it was revealed that the conversion of laser energy in the nanoparticles could be systematically controlled. This allows tuning the critical physical and chemical processes that can directly affect the ion desorption and detection sensitivity, including laser-induced heating, phase transition and surface ionization processes.

Biography

Samuel Kin-Man Lai is currently pursuing his PhD under the supervision of Dr. Kwan-Ming Ng at the Department of Chemistry of The University of Hong Kong (HKU). His current research interest is mainly focused on the study of surface-assisted laser desorption/ionization (SALDI) mechanism(s) and the development of plasmonic and/or photonic materials as substrates for surface-assisted laser desorption/ionization mass spectrometry (SALDI-MS).

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