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Mass-to-charge and Energy Distributions of Electrosprayed and Matrix-assisted Laser Desorbed Ions Measured by Nb- and Ta-Superconducting Tunnel Junction Cryodetection Mass Spectrometry

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This presentation shows applications of superconducting tunnel junctions (STJ) cryodetection in heavy ion mass spectrometry (HIMS). STJs have 100% detection efficiency at all m/z's including those with MegaDalton molecular weights (MW) as the signal output is independent of ion velocity. STJs also allow the determination of ion energy deposited into the detector which can be used for charge state discriminations and to provide information about precursor and product ions. Historically, STJs have been coupled with matrix-assisted laser desorption ionization (MALDI) time-of-flight (TOF) mass spectrometers, however, electrospray ionization (ESI) can be used to generate higher charge state ions with improved stability of intact complexes. Our goal is to characterize fragile ultra-high m/z macromolecules such as proteins and synthetic nanoparticles by using both MALDI and ESI coupled to Nb- and Ta-STJs cryodetectors. To do so using ESI, we built a custom linear quadrupole ion trap (LIT) mass spectrometer that uses kHz AC scanning techniques. To do so with MALDI, we used a modified TOF MS (Comet Macromizer). We explored the use of MS-STJ to provide MW, structural, stoichiometry and stability information for ultra-high m/z ions and to study the energy deposition dependence of these ions. Remarkable results from complexes such as ferritin, various stages of bacteriophage HK97 maturation, whole virion from cowpea mosaic virus and various nanoparticles such as quantum dots, 5nm gold particles and smaller Au-particles with gold atoms from 1 to > 500 will be presented. STJ energy data from Au₁₀(S-C₆H₄-C₄H₉)₁₀ show remarkable fragmentation patterns from at least 10 precursor ions that suggest the uses of this technique for advanced MS/MS measurements. The energy deposition between different ion types of the same mass has shown intriguing results and may allow for the determination of whether a protein is folded or unfolded from the energy deposited into the STJs alone.

Less than 5 years of experience since completion of Ph.D

N

Student (Ph.D., M.Sc. or B.Sc.)

N

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