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Characterization of Mega-Dalton-Sized Nanoparticles by Superconducting Tunnel Junction Cryodetection Mass Spectrometry

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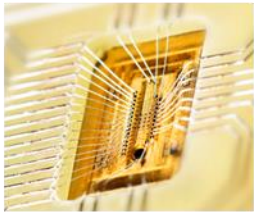
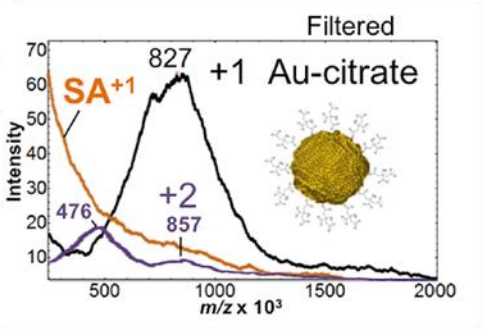
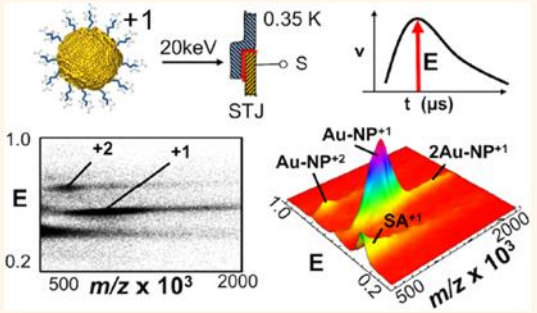
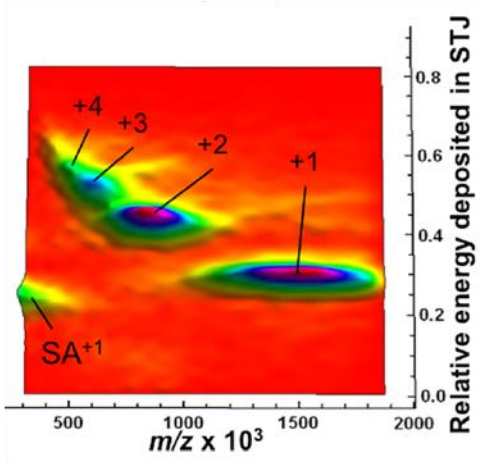




ABSTRACT: The characterization of nanomaterials is critical to understand the size/structure-dependent properties of these particles. In this report, a form of heavy ion mass spectrometry, namely, superconducting tunnel junction (STJ) cryodetection mass spectrometry (MS) is used to characterize quantum dot semiconductor nanocrystals and gold nanoparticles. The nanoparticles studied ranged in mass from 200 kDa to >1.5 MDa and included lead sulfide quantum dots, various cadmium selenide and/or telluride-based core−shell quantum dots coated with different ligands, and gold nanoparticles. Nanoparticles were ionized by both matrix-assisted laser desorption ionization (MALDI) and laser desorption ionization (LDI), shot with an aimed ion gun into a flight tube, mass separated by time-of-flight (TOF), and detected by an energy-sensitive STJ cryodetector. STJ cryodetection MS can be used to analyze intact heterogeneous nanoparticles, allowing determination of average particle mass, dispersity, and ligand loading. Some nanoparticles, however, do undergo fragmentation during the MALDI or LDI-TOF mass analyses. The measurement of the energy deposited into the detector was found to be different for different types of particles. Metastable fragments from these nanoparticles were observed at lower energies. The lower energies deposited for metastable fragments can provide insight into the stability and surface compositions of these materials. Cadmium selenide core−shell quantum dots (655 nm emission) conjugated to biomacromolecules, such as cholera toxin B and human serum transferrin, were also analyzed. When compared to unconjugated particles by mass, it was determined that ~96 cholera toxin B and ~14 transferrin proteins were attached to the surface of these nanoparticles.

KEYWORDS: *nanoparticle characterization, mass spectrometry, superconducting tunnel junction, heavy ion mass spectrometry, metastable ion, quantum dots, gold nanoparticles*





PEGylated core−shell Quantum Dots