

Metal Cluster Ion X-Ray Spectroscopy using PIPE and Traptor

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The properties of clusters like the electronic structure, geometry, magnetism or chemical reactivity are strongly depending on the number of atoms within the cluster. Preparing cluster ions in a free beam for mass-to-charge selection usually produces a dilute target for x-ray absorption spectroscopy techniques like NEXAFS for getting information on the electronic structure or XMCD for determining the magnetic moments. Confining the cluster ions into a trap can improve the target density and/or open the possibility to examine the magnetic moments and the chemical reactivity. PIPE is a permanently build up ion beam facility at the XUV beamline P04 at PETRA III, DESY, combining the preparation of free ions up to a mass of 30.000amu, with mass resolution of the preparing magnet in the order of 750, at a kinetic energy of the ions of 4keV, with XUV photons between 250eV and 3.000eV photon energy having variable polarization, high flux and high energy resolution.

Using a cluster source at PIPE we used the target preparing magnet as mass spectrometer to examine the behavior of metal cluster ions mixed at different positions of the cluster source with reactive gases like O₂, CO, CO₂, etc. The size dependent reactivity of the cluster results in various products, cluster ions with attached atoms on, whose flux is high enough to be useable in a x-ray absorption experiment.

Additionally, we build up a 16pole linear Paul trap (Traptor) designed to store in particular heavy ions prepared by PIPE and their possible fragments after photon excitation using the same operation parameters. In first laboratory experiments (mass-to-charge selected) metal cluster ions were stored and mixed with the same type of reactive gases like in the cluster mass spectroscopy experiments at PIPE. The resulting reactants are mass analyzed using an ion time-of-flight spectrometer.