MS 3: Ion Traps, Ion Storage Rings, Molecules, Clusters, Decays and Reactions

Time: Monday 15:15–17:30 Location: f128

Invited Talk MS 3.1 Mon 15:15 f128

Mass-Spectroscopic Trace of Transient Reaction Kinetics of CO Oxidation Catalyzed by Uni-Sized Pt Clusters Directly Bound to Si Surface — •Hisato Yasumatsu — Cluster Research Laboratory, Toyota Technological Institute: in East Tokyo Laboratory, Genesis Research Institute, Inc. 717-86 Futamata, Ichikawa, Chiba 272-0001, Japan

I will present mass-spectroscopic studies on low-temperature and anti-poisoning catalytic activity driven by uni-sized Pt clusters directly bound to a Si substrate surface, Pt_N/Si (N=10−71). A tandem Quadruple mass spectrometer was employed; the first one (16000 Da) selects the cluster size, N, so that uni-sized Pt_N^+ are impacted onto a Si(111) surface for their fixation on the surface, and the second one (500 Da with high transmittance) analyzes catalysis products. The highly selective, sensitive and reproducible detection of the products allows tracing their intensity transients after changing the partial pressures of reactants. In CO oxidation as an example, the transient measurements in combination with numerical simulation led to reaction rate constants of the four elemental steps; CO adsorption/desorption, O_2 dissociative adsorption and Langmuir-Hinshelwood reaction for the CO_2 production. It was found that Pt_{60}/Si and Pt_{30}/Si possess the catalytic activity 40-K lower than the Pt(111) single-crystal surface. This result was interpreted as the CO anti-poisoning nature of the monatomic-layered Pt_N/Si due to efficient activation of oxygen by electrons accumulated in a Schottky barrier junction at the sub-nano interface between Pt_N and the Si surface.

MS 3.2 Mon 15:45 f128

A 4k-pixel molecule camera for position and energy resolving detection of neutral molecular fragments — •Dennis Schulz[1], Andreas Fleischmann[1], Lisa Gamer[1], Loredana Gastaldo[1], Sebastian Kempf[1], Claude Krantz[2], Oldřich Novotný[2], Andreas Wolf[2], and Christian Enss[1] — [1]Kirchhoff Institute for Physics, Heidelberg — [2]Max Planck Institute for Nuclear Physics, Heidelberg

Stored beams of molecular ions at kinetic energies of some tens or hundreds of keV are widely used in molecular collision physics, and a mass spectroscopic identification of fragmentation products is often a key requirement for unambiguous data interpretation. For the reconstruction of the kinematics of electron-ion collisions at the Cryogenic Storage Ring (CSR, MPIK Heidelberg) we developed MOCCA, a new large-area 4096-pixel detector based on magnetic micro-calorimeters. Here, the kinetic energy deposited by a fragmented reaction product in one of the pixels is a measure of its mass, as all fragments have roughly the speed of the initial molecular ion. This calorimetric approach allows for identification of all fragments, in particular including neutrals. MOCCA has an active area of 45mm x 45mm, which is segmented into 64 x 64 absorbers, each 700μm x 700μm in size.

We discuss design considerations and present micro-fabricated detectors. We discuss the results of first tests with x-ray photons, including the uniformity of the detector response, cross-talk, multi-hit capability and the energy resolution for photons and for the massive particles. Including all effects, we expect MOCCA to easily resolve mass differences down to 1u for molecules with a few hundred mass units at CSR.

MS 3.3 Mon 16:00 f128

Production and storage of new poly-anionic metal clusters at ClusterTrap — •Markus Wolfram, Paul Fischer, Stephan König, Gerrit Marx, Lutz Schweikhard und Albert Vass — Felix-Hausdorffstraße 6, Institut für Physik, Greifswald, Deutschland

The properties of metal clusters depend on their cluster size n but also on their charge state z. The number of electrons which can be attached to a cluster depends on its size but also on the particular metal. While not many nano-systems have yet been investigated with respect to electron attachment, they may well reveal interesting properties and behavior. The aim of the present investigation is to produce new poly-anionic metal clusters by electron attachment to mono-anionic precursors. The mono-anionic clusters are delivered from a laser-ablation/He-gas condensation source and stored in a Penning Trap * simultaneously with electrons. With this so-called electron-bath technique it is possible to charge the clusters up to higher (negative) charge states. The method is currently applied to further metals, including vanadium, iron, cobalt, zinc, zirconium, niobium, tin, tantalum, titanium and lead. The measurements will provide a basis for future investigations of, e.g., the electron binding energies as a function of charge state. The project is supported by a Collaborative Research Center 652 of the DFG.

MS 3.4 Mon 16:15 f128

A Novel Laser Ablation Ion Source for Multiple-Reflection Time-of-Flight Mass Spectrometry — •Florian Greiner[1], Christine Hornung[1], Samuel Ayet San Andrés[1,2], Timo Dickel[1,2], Jens Ebert[1], Hans Geissel[1,2], Emma Haettner[2], Ivan Miskun[1], Wolfgang Plass[1,2], Moritz Pascal Reiter[1], Ann-Kathrin Rink[1], and Christoph Scheidenberger[1,2] — [1]JLU Giessen, Germany — [2]GSI, Darmstadt, Germany

At the FRS Ion Catcher, projectile and fission fragments are produced at relativistic energies, separated in the fragment separator FRS, thermalized in a gas-filled cryogenic stopping cell, extracted and transported to a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS). The MR-TOF-MS can be used for high precision mass measurements, isobar and isomer separation and for diagnostics purposes. For the calibration and for systematic studies of the MR-TOF-MS a novel laser ablation carbon cluster ion source (LACCI) has been designed, built and commissioned. This source produces ions over a broad mass range as well as isobaric calibrants It can be operated at a repetition frequency of 100 Hz in order to be compatible with the high repetition rate of the MR-TOF-MS, and . Due to an x-y-movable table the source can run stably for a long time (∼ days) and targets can be changed without opening the system. The LACCI setup also contains a thermal alkali ion source, a channeltron detector and an RFQ mass filter. It will be coupled to the FRS Ion Catcher beamline via an electrically switchable RFQ switchyard.

30 min. break

MS 3.5 Mon 17:00 f128

MAc, a software package for hardware control, data acquisition and online analysis for multiple-reflection time-of-flight mass spectrometers (MR-TOF-MS) — •Julian Bergmann[1], Alexander Pikhtelev[2], Timo Dickel[1,3], Hans Geissel[1,3], Wolfgang Plass[1,3], Christoph Scheidenberger[1,3], Samuel Ayet San Andrés[1,3], Jens Ebert[1], Christine Hornung[1], Christian Jesch[1], Wayne Lippert[1], Christian Lotze[1], Moritz Pascal Reiter[1], and Ann-Kathrin Rink[1] — [1]JLU Giessen, Deutschland — [2]Institute of Energy Problems of Chemical Physics, RAS, Moscow, Russia — [3]GSI Darmstadt, Deutschland

MAc (Mass Acquisition) is a software package designed for half-automated hardware control, data acquisition and online data analysis for MR-TOF-MS. It offers multi-dimensional automatic hardware parameter optimization e.g. electrode voltage optimization regarding transport efficiency or mass resolving power. Mass resolving powers in excess of 400.000 have been reached. MAc provides support for multiple data acquisition hardware (TDCs and ADCs), online filter features (peak detection, data smoothing etc.) and long-term measurements (days). Automated methods for peak detection and chemical compound identification are provided. Furthermore methods have been developed to visualize long-term signal stability and to correct flight time deviations due to electric field drifts by time-resolved calibration. Applications of MAc's main features for on- and offline data analysis will be presented.

MS 3.6 Mon 17:15 f128

Conceptual Design of the Cryogenic Stopping Cell for the Super-FRS at FAIR. — •Ivan Miskun[1], Samuel Ayet San Andres[1,2], Timo Dickel[1,2], Hans Geissel[1,2], Fabian Heisse[1,2], Wolfgang R. Plass[1,2], Sivaji Purushothaman[2], Moritz P. Reiter[1], Ann-Kathrin Rink[1], and Christoph Scheidenberger[1,2] — [1]II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Gas-filled stopping cells are powerful tools used to convert high-energy ion beams to ion beams with kinetic energies of few eV. At the Low-Energy Branch of the Super-FRS at FAIR a cryogenic stopping cell (CSC) filled with ultrapure helium gas at temperature of ∼ 70 K will be used to stop, thermalize and transfer exotic nuclei to high precision

trap-based experiments and laser spectroscopy. The prototype of this CSC was recently successfully commissioned as the part of FRS Ion Catcher experiment at GSI. An areal density of $\sim$ 6.3 mg/cm^2 was reached while providing short extraction times ($\sim$ 25 ms).

To meet the challenging requirements of the Super-FRS even higher areal densities are needed. Therefore, the design of a next-generation CSC has been developed based on the experience of advanced stopping cell techniques. The novel concept of CSC will provide 5 times higher areal densities increasing the stopping efficiency close to unity and increasing the rate capability by three orders of magnitude. At the same time the extraction time will be decreased down to 5 ms. Results of dedicated simulations and experiments will be presented.