

MS 5: Resonance Ionization

Time: Tuesday 14:30–16:15

Location: PH/HS2

Invited Talk

MS 5.1 Tue 14:30 PH/HS2

Resonance laser ionization for RIB production and spectroscopy in gas cells and jets — ●AIN MOORE — University of Jyväskylä, Jyväskylä, Finland

In recent years, resonant laser ionization has become a mature technique, playing a key role in the selective production of radioactive nuclides at on-line isotope separator (ISOL) and ion guide isotope separator (IGISOL) facilities. A further increase in selectivity has been successfully demonstrated whereby laser ionization is performed immediately downstream from the ion source. In connection with gas cell-based approaches, neutral radioactive atoms are selectively ionized upon exit from the cell within the expanding gas jet. By combining gas jet laser ionization with a mass separator, ultra-high purification of low-energy beams becomes a reality.

More recently, laser spectroscopy has been performed in-source to obtain fundamental and model-independent data on the structure of ground and isomeric nuclear states. In order to increase the sensitivity of such methods, the gas jet offers an attractive environment with reduced temperature and density. High power, high repetition rate laser systems with narrow bandwidths can exploit the unique opportunities offered by the gas jet.

This contribution will review the progress at existing facilities as well as presenting an outlook for the future.

MS 5.2 Tue 15:00 PH/HS2

Einsatz und weitere Optimierung der hochselektiven Laserionenquellenfalle LIST bei ISOLDE/CERN — ●REINHARD HEINKE¹, VALENTIN FEDOSSEEV², DANIEL FINK², TOBIAS KRON¹, BRUCE MARSH², SVEN RICHTER¹, SEBASTIAN ROTHE² und KLAUS WENDT¹ — ¹Institut für Physik, Johannes Gutenberg-Universität Mainz — ²EN Department, CERN, Geneva

Hochselektive Ionenquellen sind eine Grundvoraussetzung zur Untersuchung kurzlebiger radioaktiver und exotischer Nuklide, wie sie nur an modernen Isotopengeneratoren wie z.B. ISOLDE am CERN durchgeführt werden können. Die Laserresonanzionisation hat sich hierbei als weltweiter Standard mit besonderen Vorzügen in der Elementselektion etabliert. Für Anwendungen, in denen die Unterdrückung isobarer Kontaminationen durch die Resonanzionisation nicht ausreichend gewährleistet wird, wurde die hochselektive Laserionenquellenfalle Laser Ion Source & Trap (LIST) entwickelt. Diese wurde inzwischen erfolgreich in den Routineeinsatz bei ISOLDE integriert und hat Messungen an einer Reihe bisher nicht zugänglicher Isotope ermöglicht.

Der Vortrag gibt einen Überblick über aktuelle Ergebnisse des online Betriebs der LIST. Betriebsmodi und dabei erzielte Erkenntnisse sowie unerwartete Effekte, z.B. eine stark eingeschränkte Isobarenunterdrückung bei einigen wenigen Isotopen, werden diskutiert. Geeignete Weiterentwicklungen des Designs zur weiteren Steigerung von Selektivität und Effizienz werden abgeleitet und vorgestellt.

MS 5.3 Tue 15:15 PH/HS2

Resonant Laser-SNMS for spatially resolved ultra-trace analysis of radionuclides — ●MICHAEL FRANZMANN^{1,2}, LINDA HAMANN¹, KLAUS WENDT², and CLEMENS WALTHER¹ — ¹Institut für Radioökologie und Strahlenschutz, Leibniz Universität Hannover — ²Institut für Physik, Johannes Gutenberg Universität Mainz

The understanding of chemical behavior of most radionuclides in different natural compartments and anthropogenic systems, i.e. the investigation on speciation and transport mechanisms, requires more than just the determination of amount and isotope ratios of the contamination in a sample. Information about microscopic structural formation, e.g. onto nanoparticles, or sorption processes on different particle or surface materials is of primary relevance for the assessment of contamination threats. This is particularly valid in case of accidents or undeclared releases from nuclear power reactors, reprocessing plants or nuclear waste repositories. The system for resonant Laser-SNMS at the IRS Hannover is setup to combine the excellent element selectivity and efficiency of resonant laser ionization with the submicron spatial resolution and high mass resolution of a commercial TOF-SIMS. Sputtering by primary ions in combination with element selective ionisation allows to prevent chemical preparation, which most likely destroys the structural information in conventional radiometric or mass spectrometric approaches. The applied Ti:Sa laser system was developed at

University of Mainz for radioecological bulk sample analysis. The ability of this Laser-SNMS system to analyze and map ultra-trace amounts of radionuclides is currently tested on environmental samples.

MS 5.4 Tue 15:30 PH/HS2

Resonance Ionization Mass Spectrometry (RIMS) for ultra-trace analysis of Technetium — ●PASCAL SCHOENBERG¹, DANIELA SCHOENENBACH¹, SEBASTIAN ZEISEL¹, NORBERT TRAUTMANN¹, PETRA THOERLE-POSPIECH¹, JOERG RUNKE¹, TOBIAS KRON², KLAUS WENDT², and TOBIAS REICH¹ — ¹Institute of Nuclear Chemistry, Johannes Gutenberg-University, Mainz, Germany — ²Institute of Physics, Johannes Gutenberg-University, Mainz, Germany

The determination of ultratrace amounts of the long-lived β -emitter ^{99g}Tc is difficult with radiometric methods. Common mass spectrometric techniques such as ICP-MS might be hampered by isobaric interferences. RIMS provides high sensitivity and selectivity for ultra-trace analysis and isotope ratio measurements of Tc due to multi-step laser excitation and ionization in combination with a time-of-flight mass measurement.

The aim of this study was to apply RIMS for the analysis of ^{99g}Tc in environmental samples. For the determination of ^{99g}Tc in such samples, a known amount of ⁹⁷Tc is added as a tracer. The isotope shift between ⁹⁹Tc and ⁹⁷Tc is known and both isotopes can be ionized simultaneously using a three-step ionization scheme. The application of the RIMS technique to a contaminated soil sample will be illustrated. Furthermore, isotope ratio measurements of ^{97/98/99}Tc with RIMS and ICP-MS are presented.

MS 5.5 Tue 15:45 PH/HS2

Characterization of mixed Mo-Zr solution species by nano-Electrospray Ionization Mass Spectrometry — ●MEIJIE CHENG^{1,2}, MICHAEL STEPPERT¹, and CLEMENS WALTHER¹ — ¹Institut für Radioökologie und Strahlenschutz, Leibniz Universität Hannover, Herrenhäuser Str. 2, D-30419 Hannover. — ²Karlsruher Institut für Technologie, Institut für Nukleare Entsorgung (INE), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

Nano-electrospray ionization mass spectrometry is a useful tool to characterize not only stoichiometry of solution species, but also redox state. This technique is able to transfer charged species present in solution into the vacuum under soft conditions that keep the molecules intact during the whole measurement process. Mass spectrometric methods find increasingly more applications within questions arising from the nuclear fuel cycle. Both Molybdenum and Zirconium are present in spent fuel in significant amounts as high yield fission products. These two elements tend to form poorly soluble solid phases, which can disturb reprocessing steps of spent fuel as well as the immobilization of radionuclides in matrices for final disposal. By applying ESI MS to solutions of Mo and Zr at high acidic strengths we were able to detect mixed Mo-Zr precursors to the precipitates in solution and probe their abundance depending on acidic strength.

MS 5.6 Tue 16:00 PH/HS2

Isomer-selective detection of reaction products in heterogeneous catalysis in the UHV by REMPI-ToF — ●SEBASTIAN KOLLMANNBERGER, ANDREAS WINBAUER, CONSTANTIN WALENTA, JOSEF KIEMAER, PATRICK SCHREIBER, MARTIN TSCHURL, and UELI HEIZ — Lehrstuhl für Physikalische Chemie & Catalysis Research Center, Chemistry Department, Technische Universität München, Lichtenbergstraße 4, 85748 Garching bei München, Germany

Selective hydrogenation mechanisms in heterogeneous catalysis are of major importance for the development of new catalysts. One system of particular interest is the selective hydrogenation of unsaturated aldehydes and ketones. Many studies in this field are performed under low pressure or in vacuum and even on single crystals to ensure well defined conditions. Usually, product molecule detection in such studies is performed by EI ionization in a Q-MS due to the high sensitivity of this method. However, this technique allows only a limited discrimination between isobars, because of the unselective properties of EI ionization. In this work we present a TOF-MS in combination with laser ionization. Due to the setup, this system allows a very sensitive detection of isobaric species by different ionization wavelengths. The sensitivity is compared to a commercial EI-QMS. Furthermore, the

ability of isomer-selective detection is demonstrated by the desorption of ethylbenzene and p-xylene (both C_8H_{10}) as well as of their mixtures | on a Pt (111) crystal.